ABSORBING AIR FORCE FIGHTER PILOTS

Parameters, Problems, and Policy Options

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PREFACE

This report identifies and evaluates key factors that affect the Air Force's ability to provide training and experience for new, inexperienced pilots in operational fighter units. It represents a portion of continuing research sponsored by the Air Force Deputy Chief of Staff for Air and Space Operations, the Air Force Deputy Chief of Staff for Personnel, and the Air Combat Command's Director of Operations. Earlier work considered how the Air Force's loss of experienced fighter pilots could greatly increase the need for training sorties and flying hours and recommended ways of limiting the need for such increases.[1]

This report was stimulated by visits made to operational fighter units in August through October of 2000. In some squadrons, we found indications of serious training problems. With concurrence from sponsoring offices, we deferred further planned visits in order to analyze factors that might threaten other squadrons' training programs. While our previous work had found that low experience levels could create training problems in operational units, we also became concerned about an apparent excess of manning in operational units, especially in the face of a continuing shortage of pilots elsewhere in the Air Force. Through analytic calculations, this document demonstrates how carefully the Air Force must balance manning, assignment sequences and timing, training tempo, and

[1]See William W. Taylor et al., *The Air Force Pilot Shortage: A Crisis for Operational Units?* MR-1204-AF, Santa Monica: RAND, 2000.

allocation of training to new pilots in order to prevent degraded training and inadequate development of future generations of pilots.

These results should be of interest to operational commanders whose units strive to absorb new pilots without jeopardizing operational capability and readiness; to line and staff offices that develop and justify funding to support operational training, including the support of sortie generation; and to aircrew managers who bring new pilots into the Air Force, distribute them among weapon systems, and control their assignment and utilization thereafter.

This work took place in Project AIR FORCE's Manpower, Personnel, and Training Program and was completed in September 2001.

PROJECT AIR FORCE

Project AIR FORCE, a division of RAND, is the Air Force federally funded research and development center (FFRDC) for studies and analyses. It provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future aerospace forces. Research is performed in four programs: Aerospace Force Development; Manpower, Personnel, and Training; Resource Management; and Strategy and Doctrine.

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SUMMARY

The U.S. Air Force is currently confronting unprecedented problems in managing fighter aircrews. There are too few pilots in the active component, yet so many new pilots are entering the force that operational units cannot absorb them without jeopardizing readiness and safety. The 1990s saw sizable cuts in force structure, increased tasking, and fewer training sorties in all remaining active operational units. These factors are the genesis of today's absorption problems.

During site visits, we observed the adverse training environment that can result when the number of new pilots arriving at operational units exceeds the units' capacity to absorb them. At an active A/OA-10 combat unit located at Pope Air Force Base, North Carolina, for example, we found the following:

- Sixty percent (47 of 78) of assigned primary mission pilots were decertified from combat mission-ready (CMR) status.
- Pilots averaged too few sorties monthly, exhibited degraded performance in primary bombing events, and performed poorly on check rides.
- All instructor pilot (IP) and supervisor survey respondents cited problems with both the quantity and the quality of training available to inexperienced pilots. Many also expressed concern that wingmen in their units were flying advanced missions without a fundamental foundation in certain basic skills.
- Manning and experience levels exacerbated these problems. Available training sorties had to be distributed among an aircrew position indicator-1 (API-1) pilot population that was 16.7

percent overmanned and only 36.9 percent experienced even though the reported experience level was 48.6 percent.[1]

This training environment compromised both safety and readiness and compelled us to analyze its causes to see how these circumstances can be avoided. The primary cause was an excessive inflow of newly assigned pilots that overwhelmed the unit's capacity to train and absorb pilots effectively. Our research confirmed that these circumstances will continue until either training resources are increased or the flow of incoming pilots is reduced. Indeed, this unit and other affected A/OA-10 units have recovered in the period since our field visit—primarily because the flow of incoming pilots has been reduced considerably.[2]

The Air Force needs to *increase* the flow and absorption of incoming pilots, however, because pilots are in short supply. Air Force figures indicate a current shortage of 538 fighter pilots (12.2 percent of authorized positions). The current objective is to produce 330 new fighter pilots per year, but recent production (FY 2000 and FY 2001) has been about 280 pilots per year. Since the post–Cold War force reductions, the 330-pilot goal was reached only during FY 1997–FY 1999, the period that produced the new-pilot flows that overwhelmed the A/OA-10 units. These events are related because A-10 formal training units (FTUs) had greater capacity to increase production during that period than did those of other fighters.

Despite the fact that producing 330 new fighter pilots per year has been problematic, the Air Force needs to produce and absorb more than 380 new fighter pilots per year (unless pilot retention behavior can show marked improvement) in order to fill its requirements for experienced pilots. These factors make it essential to calculate the operational units' actual capacity to absorb new fighter pilots.

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[1]The cause of this disparity was the confusing method specified to calculate experience levels; there was no deliberate deception. A unit's primary mission pilots are designated *API-1 pilots*, while supervisory pilots and attached overhead staff pilots are designated *API-6* pilots.

[2]The observed conditions were representatives of all oprational A/OA-10 units, but the recovery at another A/OA-10 unit we visited at Davis-Monthan Air Force Base, Arizona, was accelerated considerably by simultaneous increases in its primary mission aircraft inventory (PMAI).

KEY PARAMETERS

The first step in this process is to determine the precise meaning of the term *absorption capacity.* Although the long-term relationships among many of the relevant parameters have been known to aircrew managers since the rated distribution and training management (RDTM) system was first implemented in the 1970s, these relationships remain complex, making it difficult to accurately calculate the effects of reduced experience and overmanning on absorption capacity. Our models are the first to achieve this goal.

Absorption capacity is determined by the number of pilots each year who successfully complete the requirements to become newly experienced.[3] Its value can be determined in stages. The factors that influence absorption capacity are shown in Figure S.1.

The first step is to determine the *training capacity* of the collection of operational units, which is essentially the pool of sorties that those units can generate and devote to training. This, in turn, depends on other parameters, such as force structure and aircraft utilization (UTE) rates. The sorties must be distributed among the pilots to determine how many are available for inexperienced pilots to fly. We must determine how many sorties can be flown by API-1 pilots because API-6 pilots should not include any inexperienced pilots among them. The API-1 sortie average, which depends on the unit's *manning level,* must be adjusted once again because supervisory requirements limit the sorties a unit's inexperienced pilots can fly on average—especially as that unit's *experience level* decreases. Another important factor is the *aging rate* of new pilots, or the rate at which new pilots accumulate experience, defined in terms of flying hours rather than sorties. This is calculated by multiplying (1) the number of the available sorties that can actually be flown on average by individual inexperienced pilots by (2) the *average sortie duration* (ASD) of

[3]Fighter pilots normally require 500 flying hours in their PMAI to become experienced pilots, although there are provisions that enable pilots with flying experience in non-PMAI aircraft to qualify with fewer PMAI hours. Pilots with 1000 total flying hours (logged as first pilot or IP time), for example, become experienced with 300 PMAI hours.

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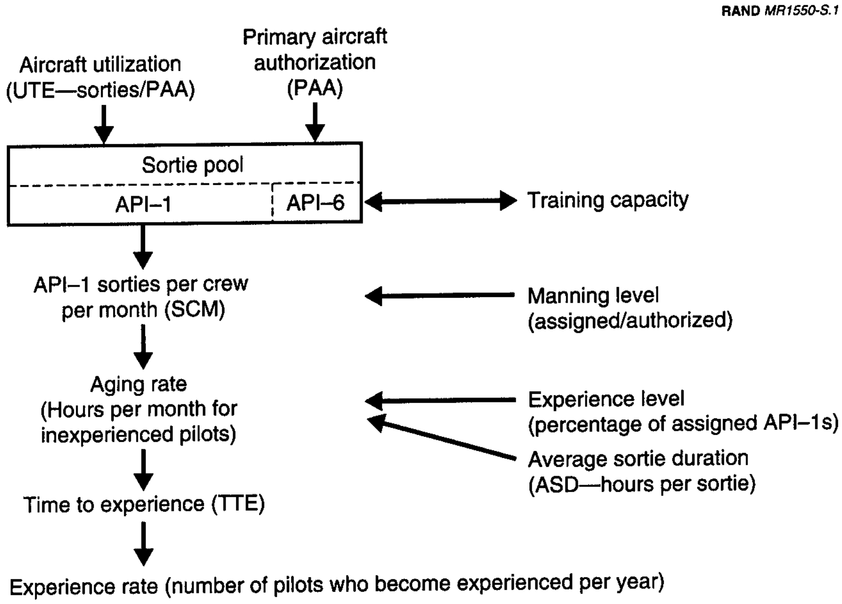

Figure S.1—A Sequence of Factors Influences the Number of Pilots Who Become Experienced Each Year

these sorties. Aging rates are derived from training capacity by adjusting for the conditions that can reduce inexperienced pilots' sortie averages and are used in turn to calculate the times to experience (TTEs) for new pilots and then the associated *experience rate.*[4]

When fighter units take in more new pilots each year than their training capacity and aging rates allow them to turn into experienced pilots, the system will begin a degradation process that will eventually drive the units to an unacceptable steady-state condition. This will further invalidate the traditional methods used to analyze the system's behavior. The rate at which new pilots can become experienced changes with time as the other parameters vary. For example,

[4]Aging rates are measured in flying hours per month. TTEs in calendar years (or months) needed to meet the *experienced pilot* definition, and experience rate in numbers of pilots who become experienced each year.

the aging rate of new pilots starts to decrease as soon as the absorption capacity is exceeded.

The RDTM system is based on setting compatible objectives that can be achieved simultaneously for a major weapon system in a viable steady state. When overall objectives become unachievable, however, the analysis must be extended to identify other conditions that might be acceptable for limited periods of time. This process introduces more changes that need to be analyzed because lower aging rates increase the time required for individual pilots to become experienced. Both of these factors exhibit dynamics that must be analyzed as well.

To illustrate the problems associated with incompatible objectives, we established a best-case scenario (BCS) on which to base our calculation of the current capacity to absorb new fighter pilots. This scenario is considered a best case for *absorption capacity* because the underlying assumptions that influence training capacity and aging rates are deliberately optimistic. They include the following:

- Flying hour programs for FY 2002 and beyond are fully funded and flown.
- UTE rate objectives are met unit by unit on the basis of FY 2002 aircraft authorizations rather than actual numbers of aircraft possessed. That is, we assume that any reductions in effective force structure that result from aircraft modernization and conversion programs can be offset either by increasing utilization of the remaining available aircraft or by another means.
- Enough experienced pilots are available to provide units with 100 percent of API-6 and 50 percent of API-1 authorizations, and the units' only source of inexperienced pilots is the FTU basic course for the appropriate weapon system. Any other entering pilots are experienced.
- API-6 sortie allocations set by current Air Combat Command (ACC) planning methods apply throughout.

On the basis of these assumptions, the absorption capacity is 302 new fighter pilots each year. This figure falls well short of the current

production objective of 330 pilots and far short of the 382 needed to fill existing requirements, assuming recent retention rates.

KEY FINDINGS

Our numerical excursions indicate that an annual production rate of 330 fighter pilots per year will take operational units into training circumstances that are very similar to those we observed at Pope Air Force Base, *even when the BCS assumptions are maintained.* That level of inflow, following historical aircrew management priorities, would push squadron manning over 140 percent in the F-15 community and almost that high in F-16s. Such levels are probably unacceptable because it would take new pilots more than three and one-half years to become experienced. That is, most fighter pilots would neither meet current experience standards nor fly enough to upgrade as IPs until late in their flying careers, if at all.

Eventually, fewer than 36 percent of the assigned line pilots would be experienced under these conditions. Thus, the question is not whether conditions such as those we observed at Pope Air Force Base would occur, but when. We need more sophisticated analytic tools to answer this question, but our preliminary results indicate that F-16 units could exceed the manning levels observed at Pope within two years. It takes a little longer to reach low experience levels because the BCS's training capacity is slightly higher than Pope could generate when we visited.

Using our models, we examined the effects of possible policy options in a search for more acceptable equilibrium conditions. One such option requires that experienced pilots be deliberately removed from operational units in order to prevent overmanning, but it is not certain that the equilibrium conditions would be viable. Indeed, the conditions are so fragile that they can be destroyed by adding more than one pilot per squadron. The proportion of experienced line pilots in this case would also drop below 36 percent.[5] Average TTEs would remain below three years, but it is questionable whether the

[5]It is a mathematical consequence of the equilibrium equation that experience will continue to drop until the system reaches equilibrium conditions at a fixed experience level that is independent of manning level.

units would have enough instructors to ensure training effectiveness and combat capability.

It remains important to estimate how quickly these conditions would occur. Our preliminary results indicate that experience levels in F-16 units will be below 40 percent within 18 months when the increased pilot flow associated with the 330-pilot production levels begins arriving in the units. Exceeding targeted manning levels by even two extra pilots per squadron would destroy the precarious equilibrium conditions. Unit manning would need to be managed nearly perfectly.

Precise management might use this option to bring fighter absorption capacities to 330 pilots per year for brief periods, but it would allow little flexibility for real-world deviations. Instabilities associated with deviations will surely become problematic if units face reductions in the sorties and flying hours available for training API-1 pilots—e.g., because of contingency tasking or aircraft modernization or conversion programs. Also recall that, unfortunately, absorbing 330 new pilots per year is inadequate to fill future requirements for fighter pilots.

Two further calculations examine the UTE rate and force structure increases, respectively, that would be needed to absorb 330 new fighter pilots per year and still meet manning and experience objectives. The results help define the magnitude of the current imbalance between planned fighter pilot production rates and absorption capacity. Beyond the best-case-assumption values, either an 8.9 percent UTE increase or an 11.1 percent force structure increase is required to absorb 330 new fighter pilots annually. The latter represents an additional 1.43 fighter-wing equivalents (FWEs).

The five numerical cases are summarized in Table S.1.

RECOMMENDATIONS

In short, the Air Force may be facing the most challenging aircrew management problem in its history. No single policy alternative can resolve all of the absorption issues in fighters. Initiatives are already under way to improve retention, use alternative manning sources,

Table S.1

Summary of Numerical Cases

Variable	BCS	Historical Default	Fixed Manning Excursion	UTE Excursion	Force Structure Excursion
Pilots absorbed	302	330	330	330	330
Manning level (%)	100	>125	100	100	100
Experience level objective (%)	50	50	Not specified	50	50
Actual experience level (%)	50	~40, 36 for F-15 and F-16	~40, 36 for F-15 and F-16	50	50
Inexperienced SCM aggregate, F-15/F-16	11 10.5/11.5	7.5 6/7	9.5 9/10	12 12/13	11 10.5/11.5
TTE (years)	<2.5	>3.5	<3.0	<2.5	<2.5
PMAI hours aggregate; F-15/F-16	570 525/575	430 350/400	525 475/520	620 585/635	570 525/575
Parameter/amount of change	NA	Manning level: >25 percent higher	Experience level: same value as default	UTE: 8.9 percent, 1.65 sorties/PAA	PAA: 11.1 percent, or 1.43 FWEs
Viable steady state	Yes	No	No; preferred?	Yes	Yes

and further improve UTE rates, and continued efforts in these areas will be critical. However, any advantages these efforts bring may simply help achieve the BCS's assumption values. Indeed, the force-structure reductions depicted in Figure S.2, expressed in terms of primary aircraft authorizations (PAA), are the primary cause of the absorption crisis in fighters.

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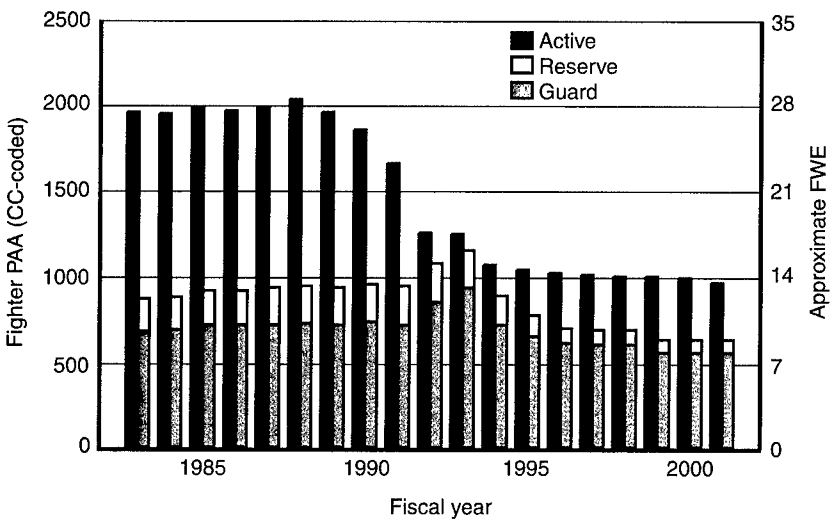

NOTE: All aircraft authorizations for operational units are combat coded (CC-coded). An approximation of the corresponding changes in FWEs is given on the right-hand axis. These numbers are approximate because they include small numbers of aircraft (such as OA-10s or air defense force [ADF]–tasked units) that are not usually included in FWE calculations. Small numbers of aircraft (such as F-117s) that do not help absorb new pilots are also included. Data are from the Air Staff (AF/XPPE).

Figure S.2—Active Fighter PAA Reductions Are Central to Current Absorption Problems

Our analyses indicate that although force structure must be addressed, it is unlikely that any approach can succeed without at least offsetting the losses in effective force structure that will come with aircraft modernization and conversion programs. Moreover, as we have noted, producing and absorbing 330 new fighter pilots per year is not enough. Unless retention improves, the actual requirement could be as high as 382 pilots per year. It could take up to four additional FWEs to absorb this many new pilots in active units, and the associated costs could prove prohibitive.

PAA increases need not, however, be achieved directly through net increases in active force structure. They can also be achieved indi-

rectly by restructuring the available force structure to increase absorption capacity. Wings containing 18-PAA squadrons, for example, need the same number of API-6 pilots as do wings with 24-PAA squadrons, so the latter can distribute more of their sorties to API-1 pilots, thereby raising aging rates and increasing absorption capacity. Moreover, the component PAA breakdown in Figure S.2 reveals a significant potential for options that use guard and reserve aircraft assets to help absorb active pilots. Thus, there are three fundamental options that can address PAA shortfalls:

1. *Direct* active PAA increases, achieved by adding new units or increasing PAA in existing units.

2. *Indirect* active PAA increases, achieved by reorganizing active units to improve absorption capacity. For example, the existing active PAA could be redistributed so that more wings contain at least three 24-PAA squadrons. This implies that some units would be closed in order to make others more robust.

3. *Effective* PAA increases, achieved by making more creative use of the force structure available in all three components. Active associate or blended units, for example, could enable the existing PAA to absorb new pilots much more efficiently than the options we evaluated using active assets only.

These options have significant budgetary implications, and their indirect costs must be evaluated as well. The second and third options, for example, may arouse serious political concerns, and the third option must also overcome cultural differences that have thus far precluded multicomponent cooperation to improve absorption. The Air Force's Future Total Force (FTF) initiative is considering active associate units and blended units—alternatives that mix assets across the components. These options seem promising for increasing absorption. Yet a number of obstacles make it unlikely that any of these options alone can resolve the absorption crisis. The Air Force must therefore examine policies that incorporate multiple options in order to resolve the crisis.

At the same time, the Air Force must find a way to grow the inventory to match requirements while simultaneously ensuring training environments that do not exhibit manning levels greater than 100 per-

cent or experience levels less than 50 percent. Other options are unacceptable for the long term.

Once an acceptable long-term solution has been identified, an implementation policy must be developed to take the units from their current circumstances to the targeted equilibrium conditions in a logical and sensible manner. This will require a better understanding of the dynamic processes that are involved, especially those associated with ongoing conversion and modernization initiatives. The problem calls for a comprehensive analytic framework that reflects a system complexity that is often difficult to grasp and communicate. A dynamic modeling framework coupled with a comprehensive longitudinal database could provide the near-real-time indicators that decisionmakers need.

If policy alternatives that enable the system to operate in viable steady-state conditions are not implemented, the Air Force will enter uncharted aircrew management territory wherein the entire active fighter community will be indefinitely exposed to the corrosive conditions that have already been observed in A/OA-10 units. Leaders will have to considerably revise their expectations regarding the knowledge and capabilities of "experienced" pilots serving in line, staff, and supervisory billets. This should not be allowed to happen by default.

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Finally, our RAND colleagues John Stillion and Bart Bennett provided thoughtful reviews of the original draft of this report, and their comments and suggestions have improved its accuracy and readability.

ACRONYMS

ABC	Aerospace Basic Course
ACC	Air Combat Command
ACIP	Aviation Career Incentive Pay
ADF	Air defense force
ADSC	Active-duty service commitment
AFI	Air Force Instruction
AFORMS	Air Force Operations Resource Management System
AFPC	Air Force Personnel Center
AFPOA	Air Force Personnel Operations Agency
AFRAMS	Air Force Rated Aircrew Management System
AMC	Air Mobility Command
AOR	Area of responsibility
API	Aircrew position indicator
AR	Attrition reserve
ASD	Average sortie duration
B-Course	Basic course
BAI	Backup aircraft inventory
BCS	Best-case scenario
BMC	Basic mission capable
BTR	Bonus take rate
CAF	Combat Air Forces
CAP	Combat air patrol
CC	Combat [coded]
CEA	Circular error average
CINC	Commander in chief
CMR	Combat mission ready
COMO	Combat-oriented maintenance organization
CONUS	Continental United States

CR	Crew ratio
ENJJPT	Euro-NATO Joint Jet Pilot Training
FAIP	First assignment instructor pilot
FG	Fighter Group
FS	Fighter squadron
FTF	Future Total Force
FTU	Formal training unit
FW	Fighter wing
FWE	Fighter-wing equivalent
FY	Fiscal year
FYDP	Five Year Defense Program; Future Years Defense Program
GCC	Graduated combat capability
HADB	High-altitude dive bomb
HCM	Hours per crew per month
I-Course	Instructor course
IFF	Introduction to Fighter Fundamentals
IOC	Initial operational capability
IP	Instructor pilot
IQT	Initial qualification training
JSF	Joint Strike Fighter
LAHD	Low-angle high-drag [pop]
LANTIRN	Low-Altitude Navigation and Targeting Infrared for Night
LIMEX	Limited experience
MDS	Mission design series
MQT	Mission qualification training
MWS	Major weapon system
OTS	Officer Training School
OVAS	Officer voluntary assignment system
PAA	Primary aircraft authorization
PACAF	Pacific Air Forces
PFT	Programmed flying training
PMAI	Primary mission aircraft inventory
POMO	Production-oriented maintenance organization
PPBS	Planning, programming, and budgeting system
QPM	Quarterly performance measure
RAP	Ready Aircrew Program
RDTM	Rated distribution and training management
RMDSS	Rated Management Decision Support System

ROTC	Reserve Office Training Corps
RTU	Replacement training unit
SATAF	Site activation task force
SCM	Sorties per crew per month
SUPT	Specialized undergraduate pilot training
TAC	Tactical Air Command
TARS	Total active rated service
TFAP	Total force absorption policy
TOS	Time on station
TTE	Time to experience
TWCF	Transportation Working Capital Fund
TX-Course	Recurrency or transition course
UFT	Undergraduate flying training
USAFE	United States Air Forces in Europe
UTC	Unit type code
UTE	Utilization [aircraft]
YoS	Year of [active commissioned] service

Chapter One

INTRODUCTION

The current pilot shortage has left the U.S. Air Force facing unusual aircrew management challenges. Many operational units have too many pilots while other organizations struggle to get the job done with too few.[1] How can both of these problems occur simultaneously?

The short answer is that the rates currently programmed for producing new fighter pilots are too low to sustain outyear requirements unless unprecedented improvements in retention can be achieved. Yet these rates will produce more newly trained fighter pilots than can be absorbed into associated weapon systems even if an extremely ambitious catalog of related objectives could be met.[2] Having too many new pilots in the absorbing units will dilute and degrade training to the detriment of readiness and combat capability. Simultaneously, critical vacancies will remain in key staff elements and other agencies that require the expertise of experienced pilots.

Aircrew management is an even greater challenge following an extended period in which an ambitious national strategy, coupled with

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[1]Operational units are the units tasked to perform the primary combat or combat support mission associated with a weapon system.

[2]Air Force Instruction (AFI) 11-412 defines absorption as "the number of inexperienced crewmembers that can be assigned to a major weapon system per year." (See Department of the Air Force, AFI 11-412, *Aircrew Management,* August 1, 1997.) We will develop this concept and address the factors that govern the numbers in later chapters. At this point, we need to stress that newly trained pilots can be absorbed only in operational units.

inadequate force structure and funding levels, resulted in marked tasking increases for a shrinking number of operational fighter units together with dwindling training resources available in the remaining units. Budgetary shortfalls precluded or delayed modernization programs to replace aging aircraft. Unexpectedly low pilot retention rates since 1997 contributed significantly to the problem's severity.[3]

This report explains the complex causes of these problems and confirms that there is no simple resolution. We will provide evidence that if the current "steady-state" approach toward aircrew management is sustained without a more fundamental appreciation of the real-time behavior of the aircrew management system, drastic negative consequences could result. These consequences can occur whenever the system operates in a regime in which small changes in key parameters can drive it across "break points" that generate dramatic changes. The continuing requirement for many new pilots, however, will virtually ensure that the Air Force will be required to manage the system successfully in such regimes unless force structure can be increased in the active component. Thus, aircrew managers and decisionmakers must fully appreciate the dynamic behavior of the system in order to recognize instabilities and avoid their potential consequences, especially when the system is forced to operate under unstable or near-unstable conditions.

As we develop and define the relationships that characterize system behavior from a dynamic as well as a steady-state perspective, we will provide a historical context from which to evaluate and apprehend the issues involved. We assign parameter values to establish a best-case scenario (BCS) on which to base our numerical excursions. Existing Air Force objectives are not consistent in the sense that they are not simultaneously achievable even under these best-case circumstances. Traditional aircrew management methods fail because

[3]That the Bottom-Up Review produced an ambitious national military strategy supported by an inadequate and underfunded force structure is a major conclusion in Eric V. Larson et al., *Defense Planning in a Decade of Change: Lessons from the Base Force, Bottom-Up Review, and Quadrennial Defense Review*, MR-1387-AF, Santa Monica: RAND, 2001. That report also documents the budgetary disconnects that derailed Air Force aircraft modernization efforts. The degradation in flying hours and other training resources began after the Persian Gulf War and continued essentially unabated until the trend was finally reversed with a concerted Air Force–wide effort to fly its annual flying hour program in FY 2000.

they assume that their objectives are compatible and that this compatibility will in turn drive the system toward a viable steady-state condition that achieves the objective values. When the objective values are not consistent, however, the system moves toward different equilibrium conditions, necessitating that more sophisticated methods be used to analyze the resulting relationships. Our numerical excursions confirm that a reliance on traditional methods alone could easily take operational fighter units into uncharted territory in terms of their manning and experience levels. This is important because these conditions can easily threaten the system's sustainability.

Chapter Two of this report examines empirical evidence that illustrates the consequences of operating fighter units in the unstable regime to which we have referred. We also explore the circumstances that enabled some units to avoid these adverse conditions.

Chapter Three begins by reviewing pilot requirement categories and their characteristics, which explain why new pilots can be absorbed only in operational units. It then looks at the training pipeline new pilots must complete to enter a weapon system inventory because no other inventory entry points are available. In this chapter, we review the steady-state equations that estimate inventory size and conclude that current fighter pilot production and retention rates will never provide an inventory that meets the relevant requirements. Retention and production excursions illustrate the extent of these inconsistencies.

Chapter Four contains a catalog of the parameters that influence absorption capacity. Definitions and relationships (including mathematical equations) are included. The discussion incorporates historical content where necessary to provide background and perspective.

Chapter Five presents the BCS's parameter values and discusses why we regard these values as representing a best-case situation. Numerical excursions demonstrate the inconsistencies associated with existing Air Force policy objectives. Using model results, we demonstrate that traditional steady-state options will place operational units in conditions very similar to those we documented in Chapter Two. Only sizable increases in the units' abilities to generate training capacity can yield acceptable steady-state conditions.

Finally, Chapter Six discusses the implications of these results and examines alternative remedies. No single alternative is likely to ensure that compatible objectives can be achieved unless one or more of the best-case parameter values can be attained. Some combination of alternatives will be needed, and the objectives will remain incompatible as the system evolves. This further emphasizes the need for more sophisticated analytic tools.

Chapter Two

EMPIRICAL EVIDENCE FROM OPERATIONAL UNITS

In this chapter, we examine empirical evidence that explores the problems encountered by operational units in meeting their training responsibilities. Operational units must take inexperienced pilots, most of them freshly qualified in the unit's primary mission aircraft, and turn them into experienced pilots who are capable of performing the unit's specific combat mission. We consider two kinds of evidence: (1) actual data reflecting sorties available, squadron manning, experience levels, and pilots' training status and qualification levels; and (2) structured interviews and surveys of supervisors and instructor pilots (IPs) conducted at operational units near the end of FY 2000. We collected data from three operational fighter bases in the United States: Pope Air Force Base, North Carolina; Davis-Monthan Air Force Base, Arizona; and Hill Air Force Base, Utah. In this chapter, however, we concentrate on the data from Pope Air Force Base because it exhibited the most severe problems.

We begin by describing training indicators that clearly document unsatisfactory circumstances for any operational unit that is supposed to stay ready to conduct combat operations with little notice.[1] It is important to discuss the indicators here because they represent conditions that might develop elsewhere unless more comprehensive databases and improved predictive analytic processes can identify timely preventive actions. Even correcting unsatisfactory conditions once they have occurred may still force the units to cope

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[1]These indicators represent only a snapshot in time, and the problems had already been identified within the Air Force with corrective action in progress when our observations were recorded.

with highly undesirable circumstances. It would be far better to prevent their occurrence in the first place.

POPE AIR FORCE BASE TRAINING INDICATORS[2]

Combat Mission-Ready Status

In the month before our visit, fewer than 50 percent of assigned A/OA-10 pilots were actually mission qualified in the sense that they were currently certified as combat mission ready (CMR) or even in basic mission-capable (BMC) status.[3] Worse, only 31 (about 37 percent) of the assigned primary mission pilots (designated aircrew position indicator-1, or API-1) were carried in CMR status. Typically, we would expect virtually all API-1 pilots who had completed initial mission qualification training (MQT) to be certified as CMR, and we would further expect the staff and supervisory pilots who had finished MQT (designated API-6) to be divided between CMR and BMC status on the basis of their specific duties. However, only six of the assigned API-1 pilots were still in MQT, leaving 47 who had lost their CMR status because they had been decertified as a result of training deficiencies. There are several potential reasons for such decertifications, but our information indicated that most occurred because the pilots had flown an insufficient number of sorties to meet CMR standards.

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[2]Our host was the 23rd Fighter Group (FG), a tenant unit at Pope Air Force Base, an Air Mobility Command (AMC) base. The group is responsible for two fighter squadrons (FSs), the 74th FS and the 75th FS. Its parent fighter wing (FW) had just changed from Moody Air Force Base, Georgia, to the 4th FW, Seymour Johnson Air Force Base, North Carolina, the month before. Squadron commanders are responsible for certifying the mission status and other qualification information for their assigned and attached pilots monthly on documents called Letters of Xs. The information cited here is from the Letters of Xs provided in July 2000, before our August visit.

[3]In AFI 11-2A/OA-10, CMR is defined in paragraph 1.4.4.1 as "the minimum training required for pilots to be qualified and proficient in all of the primary missions tasked to their assigned unit and weapon system." (See Department of the Air Force, AFI 11-2A/OA-10, Vol. 1, *A/OA-10 Aircrew Training*, February 11, 2000.) BMC is defined in paragraph 1.4.4.3 as "the minimum training required for pilots to be familiarized in all, and may be qualified and proficient in some of the primary missions tasked to their assigned unit and weapon system."

Documented Training Problems

The fact that the limited number of available sorties presented a problem was corroborated by the quarterly performance measure (QPM) data that the unit had compiled for reporting purposes. This information confirmed that API-1 A/OA-10 pilots assigned at Pope Air Force Base had averaged under six sorties per month during the first six months of 2000. This is less than two-thirds of the current Air Combat Command (ACC) objective value of 9.8 sorties per month.

Bomb scores recorded during training sorties provided documentation for another training problem for the pilots at Pope. Squadron circular error averages (CEAs) for bombs dropped in two primary events in 2000 were more than 50 percent greater than they had been for the same events in 1997, when pilots were averaging more sorties per month.[4]

The final documented problem was a marked increase in the difficulties pilots were experiencing during formal check rides. The number of unsatisfactory performances and other discrepancies prompted flight examiners to express specific concerns to us regarding check ride standards. Their dilemma was as follows: Should pilots who have been decertified from CMR status owing to lack of training still be held responsible for meeting mission standards on check rides? If not, what standards should be met? Flight examiners also expressed concern about poor performance by pilots on instrument checks. Although these checks evaluate more fundamental skills and adhere to more basic standards than do mission checks, should the pilot be held responsible for errors that result from lack of training and inadequate opportunity to practice essential instrument flying skills? Again, standards have never been set for "non-proficient" pilots. This concern has important implications for overall readiness and safety.[5]

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[4]A squadron CEA represents the mean of the distribution of bomb scores for all the record deliveries made by pilots in that squadron. The bombing events were high-altitude dive bomb (HADB) and low-angle high-drag (LAHD) pop deliveries. The actual CEA increases were nearly 12 meters in HADB and nearly 8 meters in LAHD pop, respectively. Data are from the 23rd FG.

[5]Pilots receive periodic check rides in two areas: Mission checks measure their ability to fly their combat mission, and instrument checks measure their ability to operate, navigate, and recover their aircraft in adverse weather conditions. Since check ride re-

Survey Results

During our site visit, we conducted interviews and administered written surveys to supervisors and IPs assigned to our host group. The comments and responses we received also confirmed training problems. For example, 100 percent of the respondents identified an ongoing problem with the *quantity* of training inexperienced pilots were receiving. This is a direct consequence of the lack of available sorties for them to fly.

In addition, 100 percent of the respondents identified the *quality* of training as a continuing problem. Respondents identified several causes of degraded training, some of which dealt with facility issues such as the location and adequacy of training ranges and the availability of training airspace allocations. Most respondents, however, indicated that the principal cause of diminished training quality was that too many sorties were flown by flight members whose currency or proficiency had been degraded by a lack of recent training opportunity, resulting in less realistic and less effective training missions.

The second most common cause of reduced training quality was that too many sorties had to be clustered so that pilots could regain or maintain training currencies, avoid mission status probation or decertification, or regain mission status qualification. This meant that many of the sorties inexperienced pilots received were limited to constrained profiles that prevented them from understanding more advanced mission characteristics.

The final survey result addressed the sensitive issue of safety implications. IPs and supervisors were asked whether wingmen in their units were "flying advanced missions without a fundamental foundation in certain basic skills." Almost 90 percent of respondents indicated that this was occurring at least half the time.

sults become part of a pilot's permanent record and are used to determine operational viability in competing for key positions and future assignments, poor evaluations early on could have serious career consequences.

Manning and Experience Problems

A primary reason individual pilots were flying so few sorties at the time of our visit was that almost 20 percent more pilots had been assigned to the group than had been authorized. This meant that the sortie resources that were available for training had to be distributed over a greater number of pilots than the system had intended, so each pilot flew fewer sorties on average than would have been the case at a 100 percent manning level. Again, it is useful to look at the manning problem from a primary mission pilot perspective.

The group had 84 API-1 pilots assigned against 72 authorizations, so the API-1 billets were overmanned by 12 pilots, or 16.7 percent. If the group had been able to distribute the total number of API-1 sorties per month it was averaging at the time among 72 pilots instead of 84, each pilot could have flown roughly one additional sortie on average per month. This is also a 16.7 percent increase in the monthly sortie average and, using the historical A-10 average sortie duration (ASD) to estimate the corresponding flying hours, represents 1.85 additional hours each pilot could have flown (again on average) per month. This is a significant difference.

Another problem that had an adverse effect on training at Pope Air Force Base was a shortage of experienced pilots. We will address specific definitions and examine them in a historical context in Chapter Four, but for the moment we will simply note that only 31 of the 84 line pilots assigned met existing Air Force criteria to be identified as experienced pilots. This meant that fewer than 37 percent of the assigned API-1 pilots were experienced. This is important because in our previous work, we observed that low experience levels meant that new pilots flew fewer sorties on average per month than the overall average. Thus, the new, inexperienced pilots flew even fewer than the six sorties per month that constituted the group average.[6] Indeed, group records indicate that inexperienced pilots

[6]This issue will recur throughout this report. Inexperienced pilots can rarely fly training sorties without being supervised by experienced pilots, who function either as flight leads (in single-pilot aircraft) or as aircraft commanders (in multipilot circumstances). Our research confirmed that fighter units can spread sorties uniformly among pilots of all types when experience levels exceed 60 percent but that lower experience levels require that experienced pilots fly more sorties on average than inexperienced ones. This difference continues to increase as experience levels drop. See

averaged fewer than five sorties per month during the first six months of 2000. When new pilots receive training at a rate this low, it is difficult for them even to maintain their perishable flying skills, let alone continue to develop the new skills required to acquire a fundamental understanding of the operational mission. There is also an ongoing concern that not enough experienced pilots may be available to supervise the training that the new pilots require for their development.

The experience problem was further complicated by the method used to report unit experience levels. The formula specified for use in the AFI governing aircrew management assumes 100 percent manning and can thus yield misleading results for units that are overmanned. Indeed, the reported experience level at Pope Air Force Base at that time was 48.6 percent, which is considerably higher than the actual experienced/assigned ratio of 31/84, or 36.9 percent.[7] In the presence of overmanning, experience problems can be masked by the reporting system that provides essential information to Air Force decisionmakers.

A Summary of Adverse Training Indicators

In sum, we found the following indicators of adverse training conditions:

- Forty-seven primary mission pilots were decertified from CMR status, compared with only 31 API-1 pilots who were able to maintain CMR status.
- Training documentation confirmed that pilots had low monthly sortie averages, exhibited performance degradation in squadron

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William W. Taylor et al, *The Air Force Pilot Shortage: A Crisis for Operational Units?* MR-1204-AF, Santa Monica: RAND, 2000.

[7]See Department of the Air Force, AFI 11-412, paragraph 4.5.1.2.4, August 1, 1997, for the "official" formula. It starts with the total number of experienced pilots assigned (including API-6 as well as API-1 pilots) and subtracts the API-6 authorizations to estimate the number of experienced API-1 pilots assigned. This estimate is 31 + 24 – 20 = 35 for the circumstances at Pope Air Force Base in July 2000. The formula then divides this estimate by the total number of API-1 pilots *authorized*, not *assigned*, to yield 35/72 = 48.6 percent for the Pope numbers. We will discuss both the definition and the formula in more detail in Chapter Four.

CEAs for primary bombing events, and generated concerns over poor check ride performance.

- Survey data indicated that 100 percent of IPs and supervisors were concerned that inexperienced pilots had problems with both the quantity and the quality of available training. A sizable portion also expressed concern that wingmen in their units were flying advanced missions without a fundamental foundation in certain basic skills.
- Manning and experience levels exacerbated the problems. Available training resources had to be distributed among an API-1 pilot population that was 16.7 percent overmanned and only 36.9 percent experienced even though the reported experience level was 48.6 percent.

These conditions clearly describe an unacceptable training environment with both safety and readiness problems. As mentioned previously, our intent is to identify the causal factors to see how these circumstances can be avoided. The primary cause, of course, is that too few sorties were available to inexperienced pilots.

PRODUCTION DECISIONS AND UNINTENDED CONSEQUENCES

In a seeming contradiction, the A-10 units were overmanned at the same time that the Air Force was enduring (and continues to endure) an overall shortage of pilots. This finding led us to examine the underlying factors that could create this unique condition.

Our investigation revealed that in 1996, the Air Force had decided to increase its fighter pilot production quotas to 370 pilots per year. The F-16, however, which accounts for almost half of the active fighter force, already had its training facilities operating at maximum capacity. This meant that it would take time to increase F-16 pilot production capacity. In the meantime, the production of other types of fighter pilots was increased wherever the capacity was available to do so. Although the fighter pilot production objective was reduced to 330 pilots per year in 1999, the lead time in the training pipeline caused fighter pilot production levels to average nearly 340 pilots per year for the three-year period from FY 1997 through FY 1999. Many

of the additional pilots who were produced during this period were in the A-10, and its pilot production numbers exceeded steady-state requirements by an average of almost 30 percent per year.[8]

Air Force agencies were already implementing policies to correct the problems that had been caused when the units were required to take in more new pilots than they could possibly absorb. More abiding questions were raised, however, regarding what it would mean for units to absorb new pilots and whether, given the response time of the system, the aircrew management system could recognize and react to conditions soon enough to forestall problems.

OVERMANNING AND INFEASIBLE OBJECTIVES

Our investigation and the analytic tools we subsequently developed indicate that the fighter group at Pope Air Force Base was tasked to take in more pilots than it could have trained with its available primary aircraft authorization (PAA). It could have increased its sortie production to historical highs and still have failed to meet the training objectives that were specified. Our analyses confirm that the eventual consequences when a unit is tasked to take in more new pilots than it can train will always be similar to the conditions we observed at Pope. If the unit had been able to produce additional sorties per authorized airframe, the primary difference would not have been the final outcome but only the amount of time required for the consequences to become so dire. This reflects the dynamic nature of the process when it is forced to operate in an unstable regime. We will develop this concept in subsequent sections.

The effects of overmanning are extremely difficult for a unit to control. Our models show that each additional new pilot who is added

[8]The production goal of 370 fighter pilots was set in 1996 at a Four-Star Rated Summit that also set the production goal for all pilots at 1100 per year. The April 1999 summit kept the total pilot production objective of 1100 but reduced the fighter pilot goal to 330 pilots because it was recognized that unit experience objectives could not otherwise be met. The June 2001 summit reconfirmed both of these numbers and added the proviso that all 330 fighter pilots would be absorbed in active units (30 of them had been programmed for guard or reserve units in 1999). Actual A-10 pilot production numbers for FY 1997, FY 1998, and FY 1999 were 63, 72, and 80, respectively, compared to a steady-state requirement of 56. (Data in this footnote are from AF/XOOT and the Air Force Personnel Center [AFPC].)

to an A-10 squadron subtracts roughly 0.7 sortie per month from the rate at which inexperienced pilots are gaining experience. We expect that the only way the group at Pope could have met its training objectives in a steady-state environment would have been to ensure that the parameters defining its new pilot absorption objectives were sufficiently compatible to be simultaneously achievable. This would have required that it take in fewer pilots or increase its aircraft authorizations (i.e., its force structure).

The Effect of Absorbing Fewer Pilots or Increasing PAA

Increasing PAA helped save the 354th FS at Davis-Monthan Air Force Base. The manning and experience conditions of this squadron were also quite poor in late 1999 and early 2000. In the summer of 2000, however, the squadron received six additional aircraft as part of a force structure shift. The early arrival of these aircraft effectively boosted the 354th FS from 18 to 24 PAA without an immediate corresponding increase in its manning authorizations.

Other propitious circumstances also helped the squadron overcome its problems. Because the Marine Corps volunteered to take its place for an upcoming Kuwait rotation, the squadron was able to remain at its home station while retaining its original deployment priority for spare parts and maintenance. It also received support from experienced IPs assigned to the A-10 training squadrons in their wing. When the increased pilot authorizations eventually became effective, the A-10 pilot overproduction problems had been resolved so that the new authorizations could be filled from existing pilot overages. This combination of extra airframes, priority for parts, and the opportunity to keep its experienced pilots on base to continue home-station training helped the squadron recertify most of its non-CMR pilots and markedly reduce its probationary counts by the time of our visit in the fall of 2000. The PAA increase, however, was most instrumental in resolving the difficulties.

It took much longer to resolve the problems at Pope Air Force Base, where things did not improve until well after the flow of new incoming pilots had slowed to a manageable level. This had already begun when we visited because the sustained pool of at least ten API-1 pilots undergoing initial MQT that prevailed from November 1999 until May 2000 had dropped to six by July 2000. By July 2001, the number

of pilots undergoing MQT had dropped to zero. The reduced flow of new pilots allowed total pilot manning to reach manageable levels by February 2001, although the proportion of experienced API-1 pilots did not actually begin to increase until July 2001. The number of API-1 pilots who were qualified as four-ship flight leads and IPS, however, increased steadily during 2001. Also by July 2001, only 11 API-1 pilots remained decertified from CMR status. These indicators confirm that circumstances have definitely improved, but these improvements occurred slowly and were achieved only because the flow of new pilots into the squadrons finally dropped to manageable levels.

In addition, an ACC site activation task force (SATAF) is addressing the unique problems Pope Air Force Base identified, such as low priority for certain maintenance facilities as a tenant unit and long distances from suitable range and airspace locations. The original recommendations that were driven by funding limitations may receive further review. Also, an ACC Tiger Team has examined potential means of increasing A-10 aircraft mission-capable rates.

AFTERWORD

Our purpose in documenting the circumstances at Pope Air Force Base is to illustrate circumstances that the Air Force should strive to avoid in the future. We would like to help ensure that units never have to operate in similar conditions again. To be sure, our intent is not to embarrass anyone. Indeed, the people at Pope Air Force Base who worked under these difficult circumstances deserve credit for continuing to work toward improving training opportunities as well as for maintaining remarkable morale levels in view of the existing circumstances.

The longitudinal database that we used to document the indicators at Pope and Davis-Monthan Air Force Bases may serve as a prototype for the sort of information aircrew managers may need to use in the future. The survey results are part of an ongoing effort to identify and measure actual training shortfalls in terms of individual skills and unit capabilities and to communicate the results in terms that are fully apparent to policy decisionmakers. They will be documented when that portion of the study is complete.

Chapter Three

MANAGING THE PILOT INVENTORY TO MATCH REQUIREMENTS

The fundamental objective of aircrew management is to ensure that inventories match up with requirements.[1] Because this process is considerably more complex than simply matching up the total numbers, however, it will be useful to discuss the process at some length. We first discuss the factors involved in determining requirements. Our findings indicate that not every fighter pilot is qualified to fill every requirement; in particular, the only assignments inexperienced pilots can fill are API-1 billets in operational units. Next, we explain that there are only two parameters that affect total inventory size: the production of new fighter pilots and the retention of pilots who might otherwise separate from the service. We conclude that current fighter pilot production and retention rates are too low to support an inventory that meets requirements.

Our discussion of inventory size will be limited to a steady-state condition, as might be achieved after many years of holding both production and retention at constant levels. During those many years the inventory will, of course, vary, but we have left an examination of this dynamic behavior to future research.

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[1]Aircrew management addresses total force aircrew supply and demand in the grades of O-5 and below. O-6s and above are managed separately. Our discussion deals primarily with active-duty pilots, and we will attempt to ensure that this distinction is clear whenever the discussion is expanded.

REQUIREMENT CATEGORIES

The Air Force divides pilot requirements into four basic categories: force, training, staff, and other (man-year) requirements. All of the requirements for pilots to serve in primary cockpit billets at the squadron level (i.e., all API-1 billets) are accounted for in the force and training categories. This observation will take on additional significance as we develop some of the problems associated with matching inventory to requirements.

Force Requirements

Force requirements include all of the API-1 pilots assigned to operational squadrons. Most of these requirements are determined by simple crew ratio (CR) calculations, where one simply multiplies the unit's PAA by its specified CR to determine its requirement. This requirement, in turn, is set as the unit's API-1 pilot authorization. Squadron supervisors (commanders and operations officers) constitute the bulk of the non-CR force requirement. There are also a few flying squadrons that are neither operational units nor training units (these units are typically assigned flight test missions) but are included in the Air Force's non-CR force requirement numbers.[2]

The non-CR portion of the force category is determined by the total manning requirement for the test units and by organizational parameters such as the number of operational squadrons, the PAA per squadron, and the number of squadrons per wing (for the various aircraft types).

[2]A more extensive discussion of requirements can be found in Claire Mitchell Levy et al., "Determinants of Pilot Requirements," internal document, Santa Monica: RAND, 1993, and in Harry J. Thie et. al., *Total Force Pilot Requirements and Management: An Executive Summary*, MR-646-OSD, Santa Monica: RAND, 1995. A useful treatment, including specific numbers (current as of FY 2000), is also included in Department of the Air Force, Rated Management Task Force, *Rated Management Primer*, January 1999. Requirement categories are further discussed in Department of the Air Force, AFI 11-412, August 1, 1997. Much of the material in this section is adapted from these documents.

Training Requirements

Training requirements establish IP requirements for squadrons that are tasked to provide formal training to Air Force pilots (or student pilots in training to become pilots). These squadrons further separate into two basic types: formal training units (FTUs) that conduct formal training for rated pilots, and units that provide undergraduate flying training (UFT) for student pilots who have not yet received their wings.[3] Requirements for training units are determined primarily by annual student throughput rather than through CR calculations. The student throughput numbers are calculated from programmed flying training (PFT) documents. Squadron commanders and operations officers are added to the training requirements separately, as they are in the force requirement calculations. There are also certain training units that provide additional continuation training to operational pilots whose mission limits normal training opportunities. The instructors required by these units are also accounted for separately.

The training requirements discussed in the preceding paragraph address only the IPs who are required to man the training units; the students trained in these units must be accounted for separately. The rated pilots who are enrolled in a formal flying training program are accounted for using man-year calculations similar to the "other" category that will be discussed later. This separate accounting is required by the fact that these pilots are part of the pilot inventory even though they are not available to fill specific pilot billets while they are undergoing training. Undergraduate student pilots need not be counted in this manner because their rated service has not yet started.

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[3]Air Force pilots undergo undergraduate training in several UFT options. The most common is the Specialized Undergraduate Pilot Training (SUPT) program, where students select specialized basic tracks in the T-38 (fighter/bomber), T-1 (jet tanker/transport), T-44 (turboprop), or UH-1 (helicopter) following a generic primary phase in the T-37 or T-34. The Navy runs the joint T-34 primary option, and the Navy and Army conduct the turboprop and helicopter programs, respectively. An alternative is the Euro-NATO Joint Jet Pilot Training (ENJJPT) program, which includes a limited number of U.S. Air Force students who go on to fighter or bomber FTU programs. Air Force pilots receive their wings and begin their rated service upon graduating from any of these UFT programs.

Staff Requirements

All remaining requirements for pilots in specific billet authorizations are included in the staff category. Many of these are flying billets (above the squadron level), but the category also includes all nonflying billets. Examples of flying billets include the API-6 positions required for an operational wing to accomplish its mission. Nonflying staff requirements include such positions as air liaison officers who provide tactical air control to Army units, direct staff support for warfighting commanders in chief (CINCs), or essential command-and-control functions. These requirements can be as essential to successful mission accomplishment as the primary cockpit billets.[4]

Many staff requirements are determined from organizational parameters (e.g., numbers of squadrons, PAA per squadron, and squadrons per wing). The number of staff billets required to support three F-16 squadrons at the wing level and below, for example, is essentially determined by the number of wings. This number is independent of whether the squadron authorizations are 18 PAA or 24 PAA (or a mix thereof). Staff positions above the wing level are even more dependent on organizational structure. The numbers of major air commands and numbered air forces are primary factors in establishing these requirements, as are billets that directly support joint staff requirements and warfighting CINCs.

Other (Man-Year) Requirements

The final, or "other," category does not establish specific pilot authorizations. Instead, it is based on man-year allowances and enables the assignment process to account for inherent features of the inventory that make pilots unavailable to fill specific billets. Many of these pilots are taken out of the assignment cycle to participate in career development or professional military education programs. Others are in transit between assignments or waiting out pipeline delays between courses and/or formal training programs. As mentioned earlier, rated pilots who are students in formal training units

[4]There may be legitimate concerns regarding the relative numbers of these requirements, and they undergo frequent review by the Air Force. In recent years, pilot requirements have been reduced significantly in all areas; we will return to this later.

are also included in man-year allowances. These requirements are an essential component if inventories are to be matched with requirements.

FILLING REQUIREMENTS

Each billet must be filled by a pilot with the proper qualifications. Every squadron- or wing-level flying billet, for example, must be filled by a pilot qualified in the specific aircraft mission design series (MDS) assigned to the unit. This need will often generate a formal training burden to qualify pilots for the assignment. Formal training needs include initial basic course (B-Course) training for new pilots in a weapon system; recurrency or transition (TX-Course) training for pilots returning from nonflying positions or assignments in another aircraft; and formal instructor (I-Course) training to prepare pilots to become FTU instructor pilots. Weapon systems with multiple-pilot crews often require formal aircraft commander upgrade training programs. All of these requirements generate formal FTU course obligations that add to student throughput needs and must be accounted for in the appropriate PFT documents. Many also contribute to the training pipeline delays that complicate inventory management.

Requirements are generated and tabulated by major weapon system (MWS) categories. These categories include fighters, bombers, tankers, strategic airlift, theater airlift, and helicopters. Requirements that are MDS-specific are tallied by MWS. The aircraft types (MDSs) included in each of the MWS categories are outlined in Table 3.1.[5]

Some nonflying billets can be filled by pilots of several different aircraft. A staff billet that oversees tanker availability, for example, may not need to distinguish between a KC-135 pilot and a KC-10 pilot. Similarly, certain fighter training staff positions might be filled by either an F-16 pilot or an F-15 pilot. There are also requirements for

[5]These are also referred to within the Air Force as rated distribution and training management (RDTM) categories. This is the aircrew management system that the Air Force implemented in the 1970s specifically to help future aircrew inventories meet well-defined requirements. Much of the information in Table 3.1 is adapted from Department of the Air Force, AFI 11-412, Table A.2.1, Attachment 2, August 1, 1997.

Table 3.1

Aircraft Types Included in Each MWS Category

MWS Category	MDSs Included
Fighters	A/OA-10, F-15, F-15E, F-16, F-117, F-22 (after FY 2005)
Bombers	B-1B, B-52, B-2, U-2
Tankers	KC-135, E-8, RC-135, KC-10, E-3, E-4
Strategic airlift	C-5, C-17
Theater airlift	C-130, HC-130, MC-130, C-141, EC-130
Helicopters	H-1, MH-53, HH-60, CV-22 (after FY 2005)

strategic airlift expertise that need not distinguish between C-5 experience and C-141 experience; such billets need only be MWS-specific. Others may be MDS-specific but not pilot-specific, accepting any aircrew officer (pilot or navigator) from the required MDS. B-52 and B-1 crewmembers provide examples of rated officers who might deal with global attack issues from a bomber perspective. These billets provide added flexibility that greatly facilitates the matching of inventory to requirements.

The most flexible of all requirements are those that specify a pilot (or aircrew member) from *any* MDS. Such requirements, which are called *unspecified,* are reserved for staff functions that necessitate operational knowledge in *some* mission but do not require that the nature of the mission be specified. An example could be the oversight of aircrew assignment policies and issues for the Air Staff. Finally, there are billets that have been converted to specify a general operational knowledge that could result from experience in air battle management or space operations rather than rated aircrew expertise.

Requirements in all categories have certain grade constraints that typically imply constraints on the years of service, professional development, and profiles of prior assignments of the pilots that fill them. These constraints often require that pilots shuttle between flying and nonflying (e.g., staff, professional military education) assignments, thereby increasing the formal training burden. This burden complicates the assignment process and makes it more difficult to match inventories to requirements. Yet such constraints cannot be relaxed without fundamental changes in the mission needs and required combat capabilities of the Air Force.

As we will show, the most telling constraint is that almost all categories of requirements can be filled only by experienced pilots. We will deal later with specific experience definitions, but the essence of any definition of the term *experienced pilot* is that such pilots have a thorough knowledge and understanding of the specific operational mission for which they are tasked. Staff billets, whether flying or nonflying, must be filled by officers with a fundamental understanding of the specific operational mission.

Similarly, the entire training category (which includes instructors but not students) must be filled with experienced pilots.[6] The same holds true for the entire non-CR force category as well because these are requirements for commanders, supervisors, or other pilots with special qualifications.

It is therefore clear that all newly trained pilots who complete B-Course training in an operational aircraft must initially go to a billet in an operational unit established by the CR force category. These, of course, are inexperienced pilots by any definition. Depending on the nature of the unit, such pilots will start flying either as copilots or as wingmen in the process of gaining essential experience and operational knowledge. This constraint is inherent in the nature of the requirements, and the number of such billets is rigidly set by force structure and CR policy decisions. It has not been set as a whim of inventory managers.

INVENTORY MANAGEMENT

The key feature driving inventory management is the closed and vertical structure of the Air Force pilot inventory. The only entry point into the inventory is at the bottom. This characteristic establishes several constraints.

[6]A single exception in the training category enables a few pilots to remain for instructor assignments in primary or basic trainer aircraft immediately following UFT completion, thereby delaying their assignment to an operational aircraft. Such pilots are called *first assignment instructor pilots* (FAIPs). We will see in the next chapter that the policy decision fixing the annual number of FAIPs is one of the parameters that influence absorption capacity.

Key Constraints

Two primary parameters control the size of the inventory: production and retention. Production accounts for the number of new pilots who are trained each year; retention establishes how many members of an annual production cohort remain on active duty each year. As previously discussed, new and inexperienced pilots must receive assignments to operational units as they exit their B-Course FTU programs at the end of their initial training pipeline. *The requirement to absorb these new pilots into operational units imposes a major constraint on production numbers* (and thus on the size of the inventory itself). The next chapter will address the issues associated with this absorption constraint. Production is also inhibited by the capacity of the initial training pipeline, and retention is influenced by assignment sequencing and career development opportunities. Thus, another important aspect of inventory management is the preparation needed for future jobs that sequentially follow an initial operational assignment.

To qualify for assignment to a particular billet, a pilot must previously have worked in appropriate jobs and received the training and education that is crucial to filling that billet. Pilots who now compete for an operational squadron command billet, for example, must have a career history that includes formal military educational programs, career-broadening opportunities, and appropriate staff experience as well as a fundamental understanding of the operational mission. The career sequences that meet these criteria must have been initiated a number of years in the past.

Air Force aircrew managers therefore recognize that they cannot be content merely with filling today's needs. Rather, they must simultaneously ensure that enough pilots are able to gain the qualifications that are essential to meeting future needs.

The assignment process and its difficulties, however, are not our concern here. Rather, we are interested in the problems that occur at the very start of a fighter pilot's career and the implications these problems have for supporting an inventory large enough to fill all fighter pilot requirements. The time required to prepare pilots for future job experiences depends in an essential way on the initial training pipeline.

The Initial Training Pipeline

The length of the initial training pipeline is important for inventory management because the longer the pipeline, the longer it will take an officer to become a qualified pilot, providing fewer years available to fill required billets during a typical career.

The pipeline begins when a prospective pilot receives an active-duty commission. After some delay, pilot candidates enter UFT. At the completion of UFT, they receive their pilot wings and begin active rated service. They also incur an active-duty service commitment (ADSC) that is currently set at ten years of active rated service beginning with UFT graduation. New pilots then receive (in some order) at least one survival training course; the Aerospace Basic Course (ABC), which stresses professional development for newly commissioned officers; the FTU B-Course for their specific MDS; and any additional training that is required to prepare them for FTU or for their initial assignment. New pilots in fighters, for example, must attend a formal flying course called Introduction to Fighter Fundamentals (IFF) before they begin their FTU programs. These pilots will not fill actual inventory billets until they arrive at their initial operational assignment. Man-year calculations should account for their status for the entire period between UFT graduation and arrival at their initial operational assignment. Figure 3.1 depicts this sequence of events along with typical times for each step in the process.[7] These times and the reasons for them will be discussed in the paragraphs that follow.

The delay from commissioning to UFT entry can be a year or more.[8] Although this delay has been a problem for years, it has become more crucial following some recent policy changes. Previously, pilot training candidates receiving reserve commissions from the Reserve

[7]This is the most common sequence of events, but there are exceptions that we will address later. The initial formal training for some MWS categories is called initial qualification training (IQT) instead of the B-Course terminology used in fighters, and the length of these programs varies among weapon systems.

[8]These officers are often in "casual" status with very few responsibilities. Sometimes they are assigned as overages to operational units to serve as apprentice intelligence or targeting officers. In any case, they receive no formal training until UFT entry.

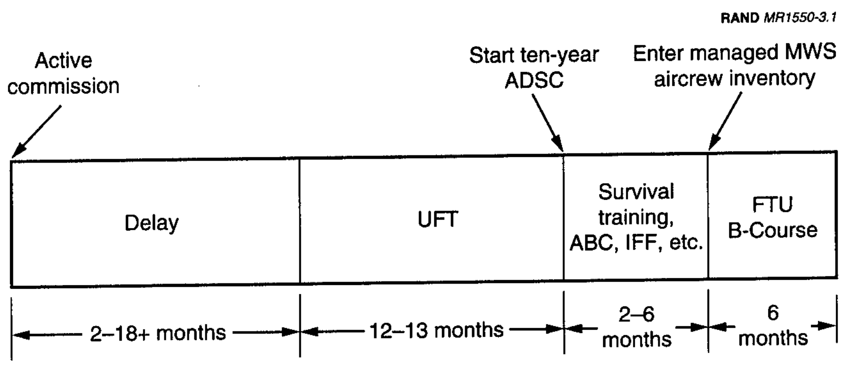

Figure 3.1—Typical Initial Training Pipeline

Officer Training Corps (ROTC) or the Officer Training School (OTS) were not brought onto active duty until they had received a class assignment and a reporting date so that they were ready to start pilot training. The delay between candidates' receipt of their reserve commissions and their opportunity to enter active service often exceeded a year, during which time they received very little credit toward pay, promotion, or retirement considerations. For several decades, Air Force Academy graduates received regular, rather than reserve, commissions at graduation, and their commissioning dates also established their active service date. Those who opted for pilot training were given priority to begin their UFT program within three months of graduation. This meant that the historical delay between the active commissioned service date and the date when the 12- or 13-month UFT training program was completed was, for accounting purposes, consistent for everyone at between 13 and 15 months.

An earlier decision to eliminate any distinction in the types of commissions granted by the three commissioning sources led to a subsequent decision in the late 1990s to eliminate the preferential treatment in active-duty service dates and UFT training selection that academy graduates had previously enjoyed. The primary outcome of this decision for our purposes is that everyone's active commissioned service date is now established when they receive their commissions. Thus, the delay between commissioning and the

completion of UFT has increased from between 13 and 15 months under the previous policies to more than two years for most officers.[9]

During the military drawdown following the end of the Cold War, decisions were made that significantly reduced student throughput capacity in both the undergraduate and FTU programs. This reduction required that such schoolhouses operate at essentially 100 percent of capacity simply to maintain steady-state pilot production quotas. This was a sizable increase from the historical average of roughly 80 percent of capacity.[10] Because fewer classes were conducted per year in each of these programs, it became harder to match the completion date from one required training program with the start date of a subsequent one, and the waiting period for officers between linked programs thus increased. Adding the ABC requirement and splitting the SUPT into separate basic tracks also reduced flexibility, further increasing pipeline delays. As a result, pilots are now taking up to 24 months of calendar time to complete the 19 months of required flying training. If we add in a one-year delay to start UFT initially, we find that some new pilots may have reached their fourth year of active commissioned service before they arrive at their initial operational flying assignments, where they can finally be counted as filling a required pilot billet. Yet the man-year allowances that should account for pilots between UFT graduation and their arrival in their initial operational billet have not been revised to capture the reductions in active rated service caused by the new pipeline delay problems discussed here. The added delay prior to UFT entry also adversely affects rated service time because the exit point for career pilots, who remain on active duty until retirement or

[9]The two years include at least a one-year pipeline delay plus another year for UFT. The official delay is even greater for a limited number of officers who are late-rated in the sense that they serve for three or four years on active duty in a nonpilot capacity before they begin their pilot training program. Many of these were navigators initially, so they actually complete two one-year UFT programs in addition to a notional three-year tour. Late-rated officers have a delay of at least four or five years between their active commissioned service dates and their active rated service dates. The background information on these policy changes was provided by the Air Staff.

[10]It is extremely difficult to operate these schoolhouses near 100 percent capacity because doing so severely restricts their ability to deal with unforeseen circumstances and dynamic factors. The capacity increase can thus be expected to cause queues and generate excessive delays. This is a well-known consequence in these circumstances. See Leonard Kleinrock, *Queuing Systems*, Vol. 1, New York: John Wiley & Sons, 1975.

promotion to O-6, is based on commissioned rather than rated service. Thus, pre-UFT delays shorten the time available to serve as a rated pilot on active duty.[11]

Managing Inventory Size

As we pointed out earlier, production and retention are the only parameters that affect inventory size in a closed and vertical system, and aircrew management policies affect both. We next discuss how these parameters interact to determine the steady-state size of the fighter pilot inventory.

The s*teady-state production quota* is the production rate that is needed to ensure that the inventory will meet requirements once it has achieved steady state. This production rate can be estimated by using year-over-year historical retention data to calculate the expected number of years pilots will serve on active duty as rated officers after they receive their pilot wings. Air Force managers call this expected value the *total active rated service*, or TARS, value. If the TARS value is representative of the average behavior of new pilots currently being produced, then the corresponding steady-state inventory relationship is given by[12]

$$\text{Inventory} = \text{TARS} \times \text{ProdRate} \tag{3.1}$$

We calculate the steady-state production quota (ProdRate) by setting the inventory equal to the requirement and solving Eq. (3.1).

Alhough this calculation gives a rough idea of the annual requirement for new pilots, several problems are associated with it. One problem is that actual inventories rarely achieve steady-state behavior. A second problem is that existing year-over-year retention

[11]The AFPC assignment staff is working with the major air commands that both train and gain these new pilots in an attempt to shorten the training pipeline. Unless they can significantly compress the initial delay of at least one year, however, these efforts will have little effect on the quoted numbers. To the best of our knowledge, the potential effect of these pipeline delays on pilot *recruitment* has not been investigated.

[12]See Department of the Air Force, *Rated Management Primer*, January 1999, for an alternative discussion of this formula.

data reflect policies in effect during the drawdown period;[13] thus, a TARS value that is based on these data may not be representative of current or future behavior.

Equation (3.1) remains true, of course, if the inventory is not set at a level equal to the requirement. As will be discussed later, the current pilot production rate is too low to support a steady-state inventory as large as the requirement. In this case, Eq. (3.1) allows us to estimate the eventual steady-state inventory from the production rate and TARS. By comparing that inventory to the requirement, we can estimate the pilot shortfall.

Equation (3.1) must be modified, however, in order to estimate the steady-state inventory of pilots available to fill requirements for a specific MWS. A limited number of pilots graduating from each UFT class are assigned to aircraft that do not meet the AFI 11-412 definition of an MWS. Many of these pilots, who do not follow the "standard" career path shown in Figure 3.1, are FAIPs who fly undergraduate trainer aircraft (T-1s, T-37s, or T-38s) in an initial assignment as UFT instructors after receiving their pilot ratings. These pilots cannot fill actual MWS billet requirements until they have completed the initial FTU B-Course associated with an MWS-identified aircraft type. For FAIPs, the TARS value will therefore fail to correspond to the expected number of years pilots serve as members of the MWS inventory.[14]

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[13]Several pilot cohorts were offered monetary incentives to separate and bonus payments to stay in alternate years during the drawdown period. Also, the Air Force's feet-on-the-ramp policy, which immediately grounded pilots who turned down the full pilot bonus (which required that they agree to remain on active duty through their 14th year of active commissioned service), meant that an inordinate number of them took the bonus (in 1994, say) and then separated as soon as the bonus payback criterion was met (about 1998). Moreover, the officer voluntary assignment system (OVAS), which was in effect at the time, caused many pilots who were at bases that were closing (or flying aircraft identified to leave the active inventory) to separate voluntarily because there were no openings for them in the operational units that remained in the active force.

[14]The same discussion applies to other pilots who have an initial non-MWS flying assignment. AFI 11-412 indicates that other non-MWS assignments include mission support aircraft such as the C-9, C-12, and C-21 plus some highly specific variants with which we will not be concerned here. These alternative flying tours are normally about three years. When pilots' formal training needs and transit times are added in, this generates an additional 3.5 years before pilots actually enter their MWS-associated FTU B-Course. Although these pilots are clearly filling billets generated by

Retention and the Bonus Take Rate

The pilot bonus program that the Air Force implemented in FY 1989 provides an alternative means of estimating retention and therefore TARS. The *bonus take rate* (BTR) is defined as the proportion of eligible pilots who accept the bonus at the end of the initial ADSC that they incurred as they received their pilot's rating. The original pilot bonus required that bonus takers commit to remaining on active duty until they reached their 15th year of active commissioned service. The Air Force modified this policy in FY 1999 to provide pilots with additional options for accepting smaller bonus payments to stay in for shorter periods of time. Then, in FY 2000, the Air Force implemented a new bonus program that gives pilots reaching their end-ADSC point several bonus options, including acceptance of the full bonus either for five years or until they reach retirement eligibility at 20 years of active commissioned service. This program retained the smaller-payments-for-shorter-periods options while also providing new bonus options at later career points for pilots whose earlier bonus agreements had ended. The most useful bonus program for estimating TARS values turns out to be the long-term commitment options that ensure maximum payments will start at the end of the initial ADSC.[15]

It is also worth identifying the timing differences that exist between pilots who have recently completed their bonus commitments (i.e., pilots who have reached the end of their bonus payback period) and those who have recently entered the pilot inventory. All pilots who have already completed their bonus payback have done so after an eight-year ADSC and thus started their rated service before the drawdown policy and training capacity changes occurred. This means that such pilots' modal end-ADSC point occurred early in

total pilot requirements while they serve as UFT instructors, they still cannot fill actual weapon system requirements until they complete formal training in that weapon system. They can typically be counted against MWS man-year requirements upon entry into the FTU B-Course.

[15]The Air Force estimates that 80 percent of the officers who elected the shorter period options in FY 2000 were not actually eligible to separate because another service commitment (generated by formal schooling or other criteria independent of their original commitment) applied. The *long-term* bonus take rate is the only one that we will use in our remaining discussion.

their 10th (or possibly 9th) year of active commissioned service.[16] Pilots governed by the ten-year ADSC (which will begin influencing end-ADSC points in FY 2008) will have incurred at least some of the additional pipeline delays described previously. This will extend the modal end-ADSC point to late in the 12th (or possibly even the 13th) year of service for these officers. Although pilots who separate from active duty at the end of a ten-year ADSC will have a TARS value two years greater than that of pilots separating at the end of an eight-year commitment, those who remain on active duty until they retire (or reach the grade of O-6) can easily have a TARS value *less* than that of their career eight-year counterparts. This is because the exit point for career pilots is determined by years of *commissioned* service, so that the extended training pipeline for the ten-year group reduces the number of years of rated service they will serve before becoming eligible for retirement or promotion. This means that the two-year ADSC increase will not generate an overall TARS increase of two full years. We will quantify this observation later.

The Air Force has recently experienced unprecedented losses of pilots from active duty. The BTR decreased from roughly 70 percent in FY 1994 to below 30 percent by FY 1997 and has remained near 30 percent in subsequent years. Unprecedented losses have also occurred after the 15th year of service following the bonus payback period.[17] The Air Force reported at the June 2001 Four-Star Rated Summit that its inventory was approximately 1200 pilots short of its requirements. The gross shortfall may, however, reveal only a portion of the problem; if the billets identified with certain requirements or MWS categories are overmanned, for example, the problem areas will have greater shortages. This leads us to examine the propensity for certain kinds of billets to be overmanned even when an overall pilot shortage exists.

[16] This is the year of active commissioned service in which *most* of the members of a pilot cohort reach their end-ADSC point in a given year. It is a more reliable forecasting tool than the mean or median year because of the skewed distribution caused by late-rated pilots and inadvertent pipeline delays prior to UFT completion.

[17] In early FY 2002, the Air Force implemented a stop-loss policy for pilots curtailing voluntary separations. This policy will definitely have a short-term effect on retention behavior, although its permanent effect is less clear.

Using the modified version of Eq. (3.1) to calculate production rates for an MWS category requires that the man-year-determined requirements be distributed by MWS. This is fairly straightforward because those that are not clearly part of one of the communities can be prorated according to the distribution of the requirements that clearly belong to a specific weapon system category. The nonflying staff requirements that generate unspecified billets can be distributed in a similar manner. The only concern here arises when specific policy decisions prevent certain types of pilots from filling some of these billets. Also, FAIPs and other pilots who do not establish their MWS category before they are assigned to valid flying billets must be accounted for. We will use BTR estimates to determine both the TARS values and the expected number of years pilots will spend in their MWS inventory. We will illustrate these issues as appropriate.[18]

RETENTION AND PRODUCTION TRADE-OFFS TO MEET REQUIREMENTS

The data scrub conducted to support the June 2001 Four-Star Rated Summit estimated that the current 1200-pilot shortfall will gradually grow to about 1300 by FY 2008. The same data indicate that the largest MWS deficit occurs in fighters, with a shortfall that currently exceeds 500 pilots and is predicted to grow to over 800 pilots (almost 20 percent of the requirement) by FY 2008. Indeed, the fighter category accounts for more than half of the total pilot shortfall by FY 2003 and continues to worsen thereafter. We have counted a normal prorata share of the man-year-generated requirements to calculate the fighter demand but have included none of the unspecified billets. This conforms to current Air Force assignment policies, which attempt to fill unspecified billets with pilots from MWS categories that enjoy overages. Although shortages occur in other MWS categories, the relative numbers are small, so the Air Force pilot shortage is essentially a shortage of fighter pilots.[19]

[18]We could modify the notation in Eq. (3.1) for FAIPs, but we defer to convention instead.

[19]The Air Force Personnel Operations Agency (AFPOA) generated the inventory estimates using the Air Force Rated Aircrew Management System (AFRAMS) model (recently developed to replace the Rated Management Decision Support System, or

If we make several simplifying assumptions regarding retention, we can estimate parameter values on the basis of the BTR value. This provides a useful steady-state analysis of the relationships between production and retention. As a point of departure, consider the following assumptions about modal pilot career behavior:

1. All pilots graduate from UFT and receive their wings and rating in their third year of service.
2. Pilots proceeding to an MWS FTU program after UFT graduation enter the MWS-category inventory in the third year as well.
3. FAIPs and other pilots with an intervening non-MWS flying tour enter the MWS-category inventory in their sixth or seventh year of service.
4. Pilots exit the pilot inventory at only two career points: (a) at the end of their initial ten-year ADSC (end-ADSC) in the 12th or 13th year; and (b) upon retirement or promotion to O-6 (as career officers) in their 21st year.
5. BTR = 30 percent; i.e., 30 percent of each cohort take the career option.

There are clearly a number of errors in these assumptions, but they tend to compensate. Many career officers remain in the pilot inventory well past their 21st year of service, for example, but many enter the inventory later than the third, and many exit at the end of their initial "bonus-payback" period in the 15th year. Pilots who are promoted to O-6 early (and even on time in many instances) also exit the inventory prior to their 21st year. This list is equivalent to assuming that the modal career pilot gives 18 years of TARS (their 3rd to 21st years), while the modal pilot who separates from active duty provides nine or ten years (3rd to 12th or 13th) of TARS. The time included in the MWS inventory is similarly calculated: It is 18 years for career officers who proceed to FTU directly from UFT, and 14 or 15 years (6th

RMDSS, referenced in AFI 11-412). Small overages currently exist in tankers and helicopters, with strategic airlift joining these MWS categories with overages by FY 2004 and sizable overages exceeding 250 pilots by FY 2006. Assignment policy information is from AFPC. Next to fighters, bombers are the most critical MWS category, but their annual deficit remains under 90 pilots, or about 9 percent of the requirement, throughout the planning horizon.

or 7th to 21st) for career FAIPs. For separating officers, the time in the MWS inventory is nine or ten years for the normal track and from five to seven years for FAIPs. We can "tune" the remaining parameters in our simplified model to replicate the most recent "Blue Line" outyear (FY 2008-plus) inventory projections made by AFPOA's AFRAMS model.[20]

These assumptions provide an overall average TARS value of just under 12.2 man-years, which is quite close to the value generated by the AFRAMS model for a ten-year ADSC.

The Air Force has been striving for several years to build its annual active-duty pilot production rate to a total of 1100 new pilots per year. The fighter pilot portion of that objective is currently set at 330 new pilots per year. These objectives will both be met simultaneously in FY 2002. We can use the calculated TARS value and the 1100-pilot production rate in Eq. (3.1) to yield a steady-state pilot inventory of 13,383 pilots, which is within one-half of one percent of the projected outyear requirement (13,319 pilots) and is thus highly consistent with recent planning decisions.

The Air Force estimate of the pilot shortage remains close to 1200 pilots through FY 2009 because the number of pilot-training cohorts who are eligible to exit in the intervening years is considerably smaller (500 to 800 pilots) owing to policy decisions made to accommodate the drawdown in the early 1990s.

In order to use Eq. (3.1) to estimate the MWS-specific pilot inventory, however, we must make the previously identified adjustments to reflect the expected number of man-years pilots will be able to fill actual MWS requirements. Thus, we must not count the rated time for FAIPs prior to FTU B-Course entry because such pilots are flying non-MWS aircraft as UFT instructors and cannot yet fill MWS-associated billets. Current production quotas include 120 total

[20]The remaining parameter values that were used are as follows: (1) one-third of the separating pilots leave in the 12th year of service (YoS12), and the remainder separate in YoS13; (2) half of the FAIPs enter the MWS inventory in each of YoS6 and YoS7. Also, the ten-year ADSC will not begin to affect exiting pilots until FY 2008.

FAIPs, 75 of whom will go to fighters. These FAIP values have been increased during recent policy decisions.[21]

When we incorporate these numbers into our simplified inventory model, the expected time each FAIP can be counted in any MWS inventory turns out to be only 8.67 man-years. In order to estimate the steady-state fighter inventory using Eq. (3.1), we must apply the formula separately to FAIPs and to pilots entering FTU following UFT. Using the 8.67 TARS value for the 75 FAIPs and adding the result to the 12.2 TARS value that applies to the remaining 255 fighter FTU graduates yields a steady-state fighter MWS pilot inventory of 3753 pilots. This is well short of the outyear requirement of 4381 but is fairly consistent with current Air Force estimates.[22] If there were no fighter FAIPs, the inventory estimate would increase to 4015, which is still well below the steady-state requirement of 4381. Flowcharts tracking the notional behavior of fighter pilots are shown in Figures 3.2 and 3.3. Both figures incorporate the production and retention parameter values used in the inventory model. Figure 3.2 exhibits fighter pilot career flows in terms of years of total active commissioned service.

Figure 3.3 exhibits the flows for fighter pilots once they are absorbed into their MWS category. This provides information regarding the number of years pilots are available to fill designated fighter billets.

We can use Eq. (3.1) to solve for the combined retention and production rates required to meet the steady-state requirement of 4381 fighter pilots. Results are shown in Figure 3.4.

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[21]The number of FAIPs was taken to zero by drawdown-related policy decisions made in the early 1990s. The numbers have been building rapidly in recent years toward these objective numbers. FAIPs are the only pilots with an initial non-MWS flying assignment who normally go on to fighters.

[22]This estimate is actually slightly above the Air Force estimate. The previously cited database for the June 2001 summit reflects a fighter pilot inventory that drops slightly below 3700 in FY 2005 and remains there through FY 2010. Anyone attempting to replicate our numbers should use TARS values of 8.667 and 12.1667 for FAIPs and non-FAIPs, respectively.

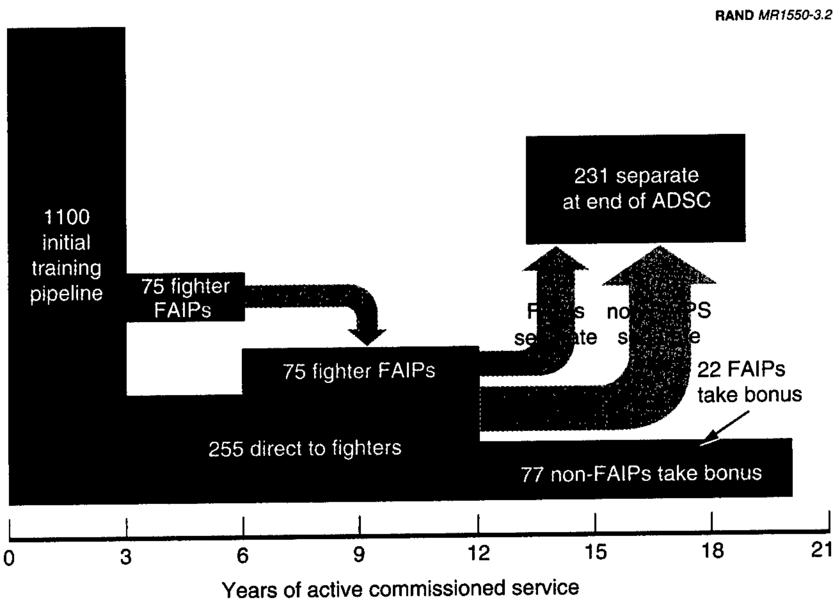

Figure 3.2—Notional Fighter Pilot Flows by Years of Total Active Commissioned Service

In order to obtain a steady-state inventory of 4381, we can increase the BTR, the production rate, or both. If production remains at 330 fighter pilots (including 75 FAIPs), the BTR must increase to almost 53 percent. Conversely, if the BTR remains at 30 percent, new fighter-pilot production must grow from 330 to 382 pilots per year (again assuming that 75 of them are FAIPs). But what are the prospects for either a higher BTR or more fighter pilot production?

Historical retention data indicate that fighter pilots may have better retention rates than the general pilot population, but a valid analysis requires that we convert the retention information into TARS values in order to conduct an "apples-to-apples" comparison. A BTR of 53 percent corresponds to an overall (non-FAIP) TARS value that is almost 14.1 man-years (as determined from Eq. (3.1)). Thus, solving the fighter pilot shortage by improving retention alone would require that fighter pilots remain on active duty almost two years longer on average than the expected value for all pilots.

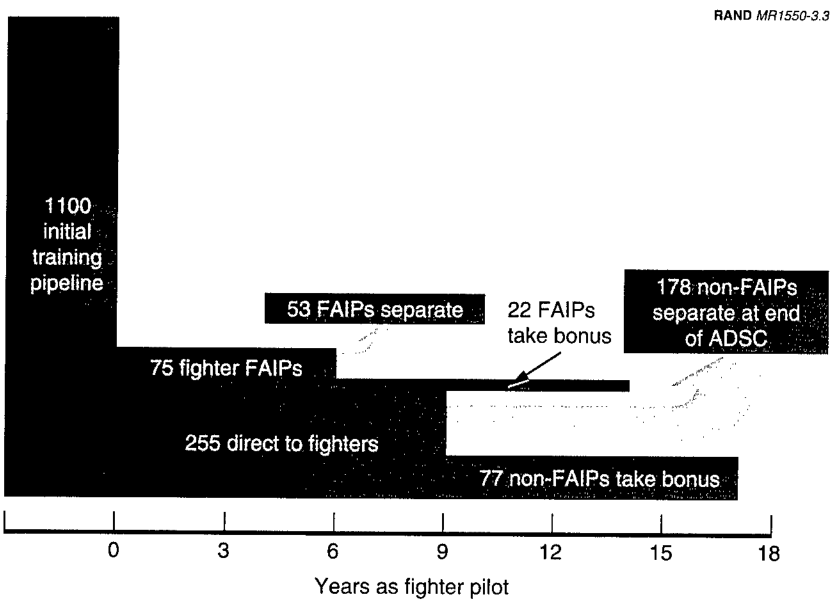

Figure 3.3—Notional Fighter Pilot Flows Following Initial MWS Absorption

This represents a significantly better retention advantage for fighter pilots than the historical data support. Recent retention data are contaminated by drawdown incentives, evolving bonus options, and stop-loss programs to support contingency operations. However, we can examine pre-drawdown retention data to obtain a reasonable estimate of relative retention rates among MWS communities. A four-year aggregation of pilot inventories and losses from FY 1986 through FY 1989 reveals a TARS value for fighter pilots that exceeds the total TARS value by nearly one man-year, which is less than half of the required premium. The actual pre-drawdown values were 12.9 man-years for fighter pilots compared to a total TARS value of 12.0 man-years. The total TARS value is lower than our current estimate because it is based on the six-year ADSC that was then in effect rather than on the ten-year commitment now in effect. Indeed, voluntary retention was significantly better during that period. In recent years,

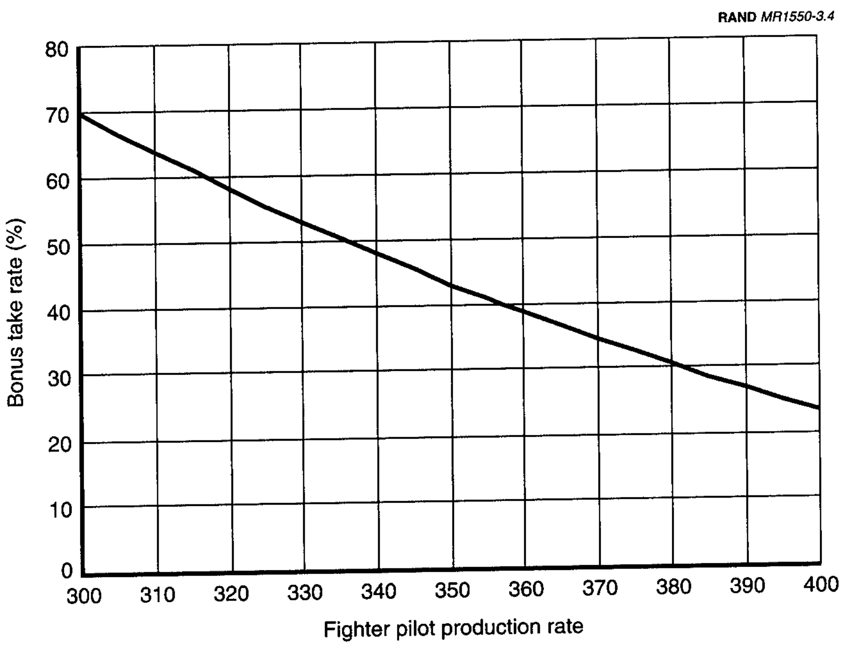

Figure 3.4—Production Rates Must Increase as Bonus Take Rate Decreases to Maintain a Steady-State Fighter Pilot Inventory of 4381 Pilots

any retention advantage among fighter pilots has essentially disappeared, so it is difficult to conclude that the shortage can be resolved through retention alone.[23]

The other option is to increase production to 382 new fighter pilots per year. As mentioned earlier, the drawdown reduced the training

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[23]We can never expect to pick up the full increase in any ADSC change in the expected number of man-years. When voluntary separation is delayed, pilots are more likely to separate at their first opportunity because they have fewer voluntary options. Also, the pilot bonus has reduced the opportunity for a "wait-and-see" attitude at end-ADSC so that pilots who stay voluntarily face longer subsequent service commitments than did their pre-drawdown and pre-bonus counterparts. As we noted earlier, the training pipeline now consumes an additional man-year in the TARS calculations for career pilots. The Air Force made the transition from a six-year to an eight-year ADSC in the early 1990s. The current ten-year ADSC applies to pilots who entered UFT in FY 1997 or thereafter. All historical retention data are from the Air Staff.

infrastructure, so producing 382 fighter pilots per year is problematic at best. Moreover, all the pilots produced must be absorbed into operational fighter units as they complete their FTU training. We will examine absorption constraints in the following chapters. Here we merely assert that the current force structure would have enormous difficulty absorbing 382 new fighter pilots per year.

We caution that the above analysis has assumed a steady state. A steady-state analysis is suggestive, but one must consider the dynamic aspects of the system to untangle the complexities of the problem.

Chapter Four

ABSORPTION CAPACITY: PARAMETERS AND RELATIONSHIPS

In this chapter, we will identify the factors that constrain the capacity of operational units to absorb newly trained pilots. We recognized in Chapter Three that newly trained pilots must first be assigned to an operational unit so that they can fly under the supervision of flight leads or aircraft commanders while they develop the operational knowledge and mission experience essential to subsequent assignments. This process of gaining operational knowledge and mission experience must be incorporated into what we mean by absorption. Although this aspect of absorption is not explicitly addressed in AFI 11-412, the explanatory text makes clear that it is an important concern. Because the capacity of operational units to absorb newly trained, inexperienced pilots is limited, a better understanding of absorption constraints and their implications is essential for policy decisionmakers. This need is not new, however, so it will be useful to consider the historical context that led to the existing aircrew management system.

HISTORICAL BACKGROUND: THE ORIGIN OF RDTM

Following the end of the war in Southeast Asia, the Air Force encountered severe aircrew manning problems. These difficulties were caused by the force structure reductions that followed the end of hostilities combined with the continued flow of new aircrews out of the sizable training pipelines that had been assembled to feed wartime combat needs. Such problems were clearly exacerbated by other factors, including changing aircrew demographics, peacetime

training constraints resulting from rapid peacetime budget reductions and the 1973 fuel crisis, conflicting residual combat attitudes, and policy decisions governing aircrew composition and combat tours.[1] The situation's severity led the Air Force to recognize that if the problem was to be corrected, a dramatic paradigm shift would be necessary to ensure that an adequate long-term aircrew management system could be developed and implemented. The new paradigm, called the *rated distribution and training management* (RDTM) system, was implemented in *USAF Program Guidance PG-77-1* dated January 6, 1975.[2] The system's purpose is quoted directly from that document:

> f. Rated Distribution and Training Management (RDTM). RDTM systematically determines the interrelationships existing between various individual weapon systems and other functional areas and then manages all functions associated with those weapon systems in such a manner that requirements of each weapon system are met. To accomplish the foregoing, both requirements and resources need to be identified and projected throughout the Five-Year Defense Program in order to determine the training required to bring the two into balance. . . .
>
> (1) The FYDP training rate is used as a departure point to define short-term absorption (*the ability of a weapon system to accept new pilots and maintain an acceptable experience level in the cockpit*). Computations on absorption are a function of cockpit positions, experience definition, percent experience desired, the formal course washout rate, and the time (years/months) to reach experienced status. . . . Absorption models are on line for all weapon systems and are used to compute UPT/FAIP distribution.[3]

The importance of turning new pilots into experienced ones in the absorption process is clear in the above context, and our list of ab-

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[1]These factors are developed in detail in C. Richard Anderegg, *Sierra Hotel: Flying Air Force Fighters in the Decade After Vietnam*, Washington, D.C.: Air Force History and Museums Program, 2001.

[2]Headquarters (HQ) USAF, *USAF Program Guidance PG-77-1*, Section C, paragraph 4-10, January 6, 1975, pp. 4–20.

[3]The emphasis on the absorption definition is ours. We should note that the FYDP has since been extended and renamed the Future Years Defense Program, but its purpose remains essentially unchanged.

sorption constraints will not differ dramatically from that given in this quotation.

The steady-state absorption models for each MWS category cited in the quotation above was an approach toward aircrew management that represented a significant advance over previous efforts. However, additional challenges have emerged during the past decade as a result of an ambitious defense strategy that was inadequately supported by a reduced and underfunded force structure.[4] We will see that these challenges require that the RDTM concept be expanded to incorporate a systemic approach toward aircrew management that also captures the dynamic properties of the behavior both within and among MWS categories.

We will continue to discuss additional original RDTM innovations as they pertain to our development of the absorption constraints.

ABSORPTION, PRODUCTION, AND ABSORPTION CAPACITY

Most of the terms that we will use in the sections that follow are already familiar. We will develop them here, however, because of their importance and because precise terminology is essential to our modeling effort, which enables us to examine numerical excursions for a variety of parameter values.[5] Our point of departure is the AFI 11-412 definition of absorption.

Absorption

Recall the AFI 11-412 definition: "Absorption is the number of inexperienced crewmembers that can be assigned to a major weapon system per year."

Although this definition seems clear, experience compels us to discuss it more fully. Two key issues need to be addressed in this context. The first is to accurately identify the source of these inexperienced pilots. Because pilots are assigned to an MWS, absorption ignores any UFT graduates who initially go to flying

[4]See Larson et al., 2001.

[5]Several of our models are documented in a forthcoming RAND publication.

assignments in non-MWS aircraft. This means that the absorption process will not deal with FAIPs, for example, until they have completed their UFT instructor assignments and have entered the appropriate FTU B-Course or IQT program to become qualified in their specific weapon system. Thus, the source of the inexperienced crewmembers to be absorbed (in accordance with the definition) will be the FTU B-Course (for fighters) or the initial IQT program (as appropriate for other MWSs).[6]

The second issue is to establish when the absorption process terminates. There is a definite experience condition implied in AFI 11-412, and the same paragraph that states the absorption definition also establishes the approval authority for constraining absorption because of experience. Indeed, the italicized portion of the RDTM statement of purpose quoted above confirms that a primary objective in introducing the absorption concept is to provide a means of managing experience within a weapon system. This is readily accomplished by tracking the inexperienced pilots assigned. We will thus concur that the absorption process terminates once new pilots have become experienced in accordance with the rules that apply for the appropriate weapon system. We will develop precise definitions soon, but first we turn to production.

Production

Although we have established a very close relationship between absorption and B-Course production within an MWS, there is a clear difference in meaning between the two. The RDTM purpose statement and AFI 11-412 both make it clear that absorption concerns should *constrain* production. Indeed, RDTM provided the first formal recognition of this fact by the Air Force. Historically, fighter pilot production had to be dramatically increased during wartime to meet combat needs, and newly trained pilots were rushed into combat from replacement training units with little concern for their initial training adequacy or for their future development as fighter pilots. The following description captures the essence of that approach:

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[6]The definition quoted is given in Department of the Air Force, AFI 11-412, paragraph 4.5.1, August 1, 1997. We will deal primarily with fighters, so we will use the term *B-Course* for the initial formal training course required for any weapon system.

> No one who attended a replacement training unit (RTU) during the Vietnam War would deny that the mission of those squadrons was to mass-produce fighter pilots to fill wartime cock-pits. . . . Everything they needed to know to survive combat and become an efficient killing machine had to be learned in the RTU. These schoolhouses for fighter crews were the only chance for learning before the crucible of combat. Nonetheless, most who attended them remember the schoolhouse as a poor learning experience that did not adequately prepare them for the rigors of war.[7]

Clearly, absorption was not a concern at that time. The training revolution that would follow, however, was designed to correct the aircrew and aircraft losses experienced by units flying combat in Southeast Asia—an effort that was prompted by Air Force leaders' recognition that more of these losses were caused by lack of experience than by enemy fire.[8] It had become clear that the collective experience of a unit's pilots provides a useful indicator of that unit's readiness and combat capability.

We will see that pipeline capacity and absorption should impose upper, or maximum, constraints on production, while Eq. (3.1) establishes a desired lower, or minimum, limit (for given requirements and retention rates). We will use the term *production rate* to indicate the annual B-Course output of pilots in a specific aircraft weapon system type (or MDS). We can then obtain the production rate for an MWS category by aggregating production rates for the appropriate MDSs.[9]

It will remain essential to separately track who enter their B-Course directly from UFT and those (such as FAIPs) who enter from a non-MWS aircraft because pilots who are late arrivals into their MWS inventory are expected to benefit from the additional flying experience they gain during their intervening tour. The system assumes that such pilots will be able to acquire essential experience—i.e., will

[7] Anderegg, 2001, p. 17.

[8] Anderegg, 2001. The primary focus of the book is the training revolution that the Air Force achieved in the decade following the Vietnam War. This revolution took place in association with RED FLAG, the aggressor program, and other innovations that occurred during that period.

[9] One can make a strong case that the absorption constraint should be included in the pipeline capacity because of the limit it imposes on new pilot production rates.

complete the absorption process—more rapidly once they begin their operational flying, and many are indeed qualified to function as flight leads and aircraft commanders sooner than their B-Course contemporaries who came directly from UFT.

It is important to distinguish between programmed and actual production rates because every pilot who completes B-Course FTU training each year must be assigned to an appropriate operational unit, irrespective of whether absorption constraints are met or violated. This can create some definitional confusion because the Air Force typically identifies these pilots as having been absorbed with no explicit reference to the fact that their absorption process must continue until they become experienced. Absorption constraints have previously been interpreted to limit the number of new pilots who can be assigned each year rather than the total number who are still participating in the absorption process. The latter number, of course, would correspond to the total number of inexperienced pilots. These distinctions may become clearer once the formulas that govern the relationships have been developed.[10]

Absorption Capacity

Specific objectives are set for operational units to maintain readiness and combat capability. These objectives include acceptable experience and manning criteria for the units. Lengthy lists of absorption constraints to support these objectives are given both in the RDTM purpose statement and in AFI 11-412 in the form of upper, or maximum, limits imposed on the numbers of new pilots who can enter a weapon system (or MWS category) while still allowing the system to meet the criteria essential to maintaining unit readiness and combat capability objectives. In aggregate, these constraints define the *absorption capacity* of the system under review in the sense that the absorption capacity represents the maximum number of new pilots who can be absorbed without violating any of the specified objec-

[10]Our terminology throughout this section incorporates the Air Force's traditional policy of absorbing entire active FTU production cohorts only in active units. A total force alternative that could absorb some number of active pilots in operational guard or reserve units will be examined independently.

tives or aspiration levels.[11] We will soon interpret several absorption-capacity excursions, but this will first require a thorough understanding of associated parameters and their interrelationships.

Preliminary Discussion

Before we proceed, it may be useful to examine some of the factors that influence the issues associated with absorption capacity. These factors are depicted schematically in Figure 4.1.

RAND *MR1550-4.1*

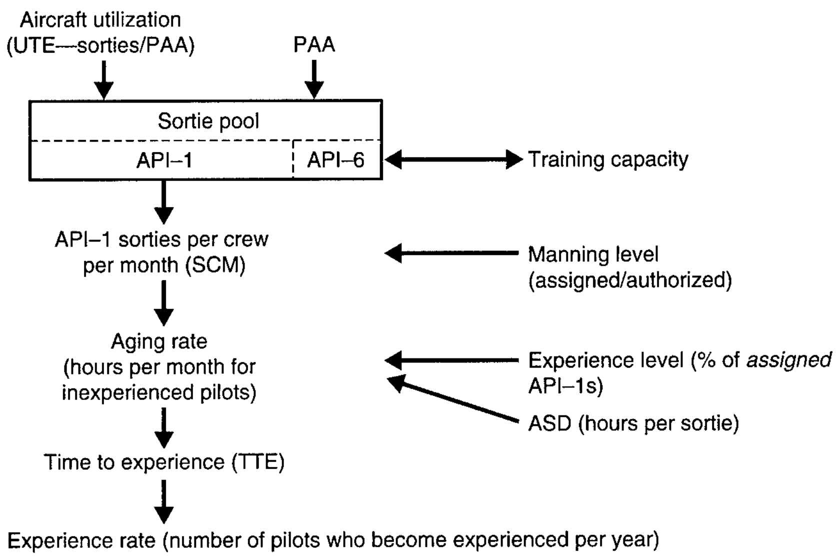

Figure 4.1—A Sequence of Factors Influences the Number of Pilots Who Become Experienced Each Year

[11]We will use the term *system* as a generic reference that includes the API-1 pilots assigned to a unit, a weapon system (or MDS), an MWS category, or any other useful aggregation.

Production and absorption are clearly related by how long it takes new pilots to become experienced (the *time to experience*, or TTE) and by how many of these pilots can complete their absorption process by becoming experienced each year (or *experience rate*).

Beginning at the top of Figure 4.1, aircraft utilization, or UTE (in sorties per PAA), and PAA numbers determine the monthly sortie pool that is available to a unit for operational training. This pool defines the *training capacity* that is available to a unit (or an aggregation of units). Since API-6 pilots should already be experienced, these sorties must be distributed between API-1 and API-6 pilots, and the API-6 sorties are omitted from further calculations. We next divide the API-1 sortie total by the number of assigned API-1 pilots to determine the average sorties per crew per month (SCM) for these pilots. When units have a greater number of assigned pilots than they are authorized, this average will obviously decrease.[12] This is important because operational units historically become overmanned when the flow of incoming new pilots exceeds their training capacity for any period of time, as the Pope Air Force Base example illustrates. The API-1 sorties must also be distributed between experienced and inexperienced pilots because, as documented in our previous work, lower experience levels mean that new pilots fly fewer sorties on average per month than the overall average.[13]

The *aging rate* is the number of hours inexperienced pilots are able to average each month. This factor can be calculated by multiplying the average number of monthly sorties inexperienced pilots are able to fly by the average number of hours per sortie (i.e., the ASD). Aging rate thus depends on a unit's ASD as well as on its experience level. When experienced pilots are defined in terms of flying hours (as is currently the case), the TTE can easily be calculated from the flying-hour requirement and the aging rate. The TTE can then be used to determine the number of pilots who become experienced each year.

The primary factors are illustrated here for convenience. We will now turn to a more detailed examination of all the parameters that influence these factors.

[12]Moreover, if fewer pilots are assigned than authorized, the unit may have serious problems accomplishing its specified mission.

[13]See Taylor et al., 2000.

PARAMETERS THAT INFLUENCE ABSORPTION CAPACITY

Now that we have agreed that absorption capacity is the maximum number of pilots that can be absorbed by a weapon system (or MWS category) while still allowing the system under review to meet prescribed objective, or aspiration, levels, it will be useful to examine in more detail the factors that determine these levels. These objectives are important because many of them play a critical role in determining readiness issues or combat capabilities for units and MWS categories. The RDTM paradigm incorporates the fundamental assumption that these objectives are compatible (or simultaneously achievable) in the sense that the system can be tuned to achieve a steady-state condition with absorption capacity that meets them all. We will confirm that such steady-state conditions occur only when the number of new pilots who enter the system each year does not exceed the number that the system turns into experienced pilots. When the absorption constraints become inconsistent for a system of interest so that they cannot be met simultaneously, we will discover that the parameter values start to vary over time, necessitating more advanced analytic methods to track these changes.

Absorbable Billets

The billets to which new pilots can actually be assigned are called *absorbable billets*, and their number clearly imposes related constraints on possible production goals. The demand-side requisites ensure that these billets must all be line pilot (i.e., API-1) billets in operational units. Unfortunately, not all of these API-1 billets are absorbable. Certain aircraft have mission demands and crew compositions that prevent new pilots from being assigned to these aircraft until they have become experienced in a related aircraft type. Current aircraft with such constraints include the F-117 in fighters, the U-2 in bombers, and the E-4 in tankers.[14] Additionally, as new aircraft types replace older ones in the force-structure inventory, restrictions are often placed on assigning new pilots to these aircraft.

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[14]The B-2 was previously limited to experienced pilots only, but the Air Force recently initiated a controlled program to absorb small numbers of new pilots (two UFT graduates and five FAIPs per year) into the B-2. These numbers are perhaps more significant than they seem owing to the small size of the B-2 community.

Such restrictions are required to ensure safety and supervision during the initial phase of the transition period, so they apply for only limited periods of time. Nonetheless, they limit the available absorbable billets during the period of transition, and these limits are exacerbated when delays occur and cause initial operational capability (IOC) dates for the new aircraft to slip. Aircraft replacements scheduled to start during the current planning horizon (i.e., the FYDP) include the F-22 (replacing F-15s) and the CV-22 (replacing HH-60s).

Even when the number of absorbable billets remains stable, these billets cannot all be filled with brand-new pilots. Sufficient numbers of experienced pilots are required in these billets to ensure that the operational units have adequate numbers of flight leads or aircraft commanders to allow for safe and effective flying operations. Operational unit experience levels clearly depend on the proportion of the API-1 billets that are filled by experienced pilots. Indeed, we will soon use this concept to define unit experience levels. Thus, it remains important to recognize the distinction between the number of billets that are absorbable and the number of new pilots who can actually be incumbent in these billets at a given point in time.

Finally, because all pilots must initially mature in absorbable-billet assignments before they become eligible to fill nonabsorbable-billet requirements in any MWS category, the rates at which pilots gain experience as well as pilots' retention rates are also important factors in building steady-state inventories that adequately fill requirements. Increases in either of these rates can require extensive resource expenditures so that MWS categories with larger ratios of nonabsorbable to absorbable billets (the nonabsorbable-to-absorbable ratio) will have greater problems developing adequate inventories than will those with smaller ratios. This is because pilots may need to mature more rapidly or exhibit higher retention rates to be able to flow through the relatively smaller numbers of absorbable billets and become eligible to fill relatively larger numbers of nonabsorbable (or advanced) ones.

Figures 4.2 and 4.3 show historical changes (for total billets and fighter billets, respectively) in nonabsorbable and absorbable billets since the military drawdown began. The total pilot nonabsorbable-

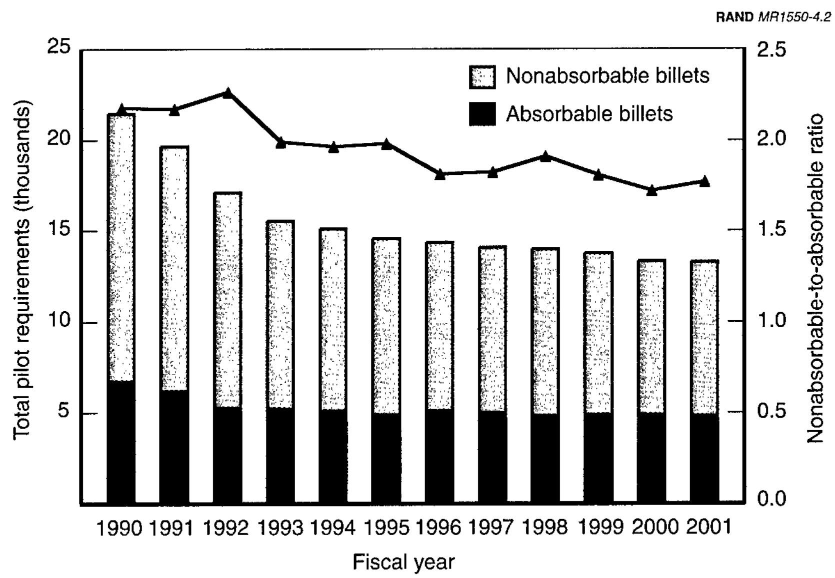

Figure 4.2—The Nonabsorbable-to-Absorbable Billet Ratio Has Improved from 2.18:1 to 1.77:1 for Total Pilot Requirements Since FY 1990

to-absorbable billet ratio decreased from 2.18:1 (2.18 advanced billets needing to be filled for each billet capable of accepting entering pilots) in FY 1990 to only 1.77:1 in FY 2001, implying an improved ability to meet requirements through adequate inventory growth. During the same period, however, the nonabsorbable-to-absorbable billet ratio for fighters increased from 1.82 to 2.73 advanced billets for each absorbable billet, implying a degraded opportunity to absorb pilots in sufficient numbers to meet requirements for this MWS. These numbers are not unrelated to the production-retention excursions that we conducted in the preceding chapter. It is interesting to note that bomber requirements also became more difficult during the same period, with the ratio increasing from 1.21:1 to 3.22:1. Since bombers and fighters represent the primary combat weapon systems (the others are basically combat support), this implies an increasing need for combat expertise among the advanced billets. This is the result of steady requirement numbers for joint billets (which are

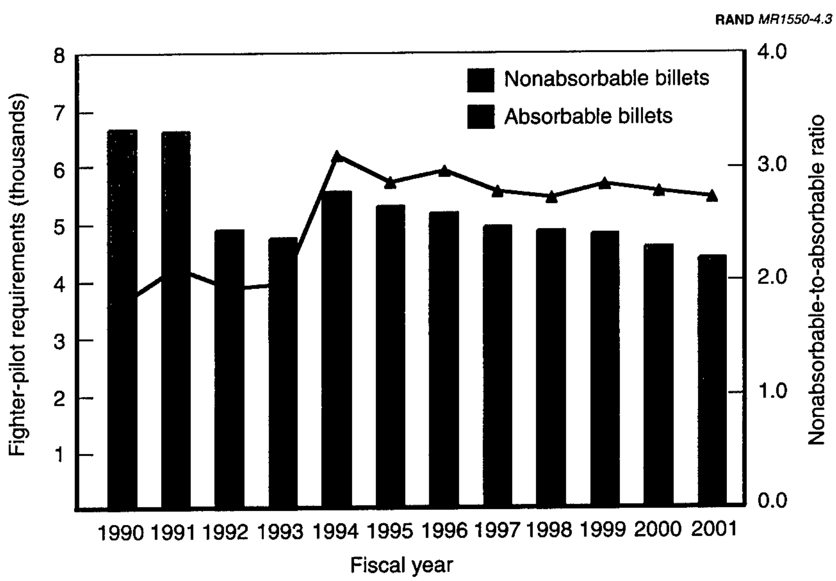

Figure 4.3—The Nonabsorbable-to-Absorbable Billet Ratio for Fighters has Worsened from 1:82:1 to 2:73:1 Since FY 1990

responsible for integrating air operations with land and sea alternatives) plus an increasing emphasis on the command-and-control aspects of combat operations that evolved during this period.[15]

The number of absorbable billets depends directly on active force structure decisions because all of the absorbable billets are determined by CR calculations. A key component of the data depicted in Figure 4.3 is that force structure reductions have decreased the number of absorbable fighter billets by a full 50 percent since 1990, while the nonabsorbable billets have decreased by only 25 percent in the same period. The reason for this disparity is that the staff and other advanced requirements that constitute the nonabsorbable billets do not respond directly to force structure changes. Throughout the

[15]All data in this paragraph, including the method used to distinguish between absorbable and nonabsorbable billets, are from AF/XOOT. It is also clear that one may infer that other MWS categories have improved (at least in aggregate) during the drawdown period.

drawdown, the Air Force could not gain congressional support to close enough bases to achieve the organizational changes that would bring nonabsorbable billets down in proportion to the force structure reductions achieved among the operational active fighter units.[16]

This means that there are three distinct aspects of absorbable-billet reductions that will continue to cause absorption concerns. The first is the number of *absolute* reductions that occurred in conjunction with force structure changes in active forces throughout the drawdown period. The second is the *relative* decrease in absorbable billets that occurred in fighters and bombers during the same period (in relation to the nonabsorbable billets). The third concern deals with the consequences of the *effective* reductions in force structure that will be caused by long-delayed aircraft replacement and modernization programs currently scheduled for the future.[17] All of these factors have serious absorption implications.

Some sample numbers might help illustrate these issues. Current programming documents identify 1223 absorbable fighter billets and 3158 nonabsorbable billets in the steady-state requirement for 4381 fighter pilots. The current Air Force experience objective is to fill at least 50 percent of the absorbable billets with experienced pilots, leaving 611 absorbable billets that can be filled with inexperienced pilots. If the production rate is 330 new fighter pilots per year (the current Air Force objective), these pilots would have to become experienced in roughly 22.2 months (on average) in order to avoid having more than 611 inexperienced pilots assigned to absorbable billets.

Unfortunately, current programmed UTE rates will not provide an adequate training capacity to enable new fighter pilots to become experienced that quickly, and we have already confirmed that this

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[16]An additional factor is the "fixed" manpower cost required to maintain the joint global command-and-control structure that was discussed previously. These manpower requirements have been relatively insensitive to force structure reductions.

[17]Fighter modernization programs are required to extend the service life of F-16 and A/OA-10 aircraft until they can be replaced by the Joint Strike Fighter (JSF), whose IOC date is currently scheduled for 2014. Slips in this IOC would complicate matters even further. It is interesting to observe that the IOC date for the F-22 at the corresponding stage of its development was 1994.

production rate will require a 53 percent bonus take rate to generate a steady-state inventory of 4381 pilots. Alternatively, if none of the new fighter pilots were FAIPs, current training capacity would limit new fighter pilot production to only 266 pilots per year and would require a BTR of 82 percent in order for the inventory to match requirements. If we include the 75 FAIPs who are currently programmed for fighters, then new pilots can become experienced in just over two years (on average), and the production level drops to about 300 pilots per year to ensure that no more than 611 inexperienced pilots are in absorbable billets.[18] As we discussed in Chapter Three, this production rate requires a 70 percent BTR to match inventory to requirements.

Experienced Pilot Criteria

The term *experienced pilot* defines a pilot who has completed the absorption process and can be assigned to more advanced billets. The need for a precise and objective standard that measures experience led to the use of a RDTM-implemented flying hour–based criterion in place of previously used subjective descriptions such as "fundamental understanding of the operational mission" and "operational knowledge and mission experience." The requirement for fighter pilots to become experienced, for example, is 500 flying hours in the primary mission aircraft for pilots who proceed directly to fighters from UFT. For pilots (such as FAIPs) with an intervening non-MWS flying assignment, the requirement is 1000 hours of total flying time and 300 hours in the primary mission aircraft.[19] Other MWS categories have similar requirements, although the number and nature of the required hours will change in accordance with mission and training differences among the categories.

The essential component involved in setting the standards is a general understanding that meeting the objective criterion ensures the

[18]This value is calculated as a weighted average of 75 FAIPs who become experienced in about 14.5 months and 225 non-FAIPs who become experienced in about 27.6 months.

[19]The total hours must be logged as first pilot or IP time; copilot time is not allowed. To allow for changes from one aircraft to another, the provision is 100 hours in the primary mission aircraft for pilots who were previously experienced in another fighter.

fulfillment of the subjective description as well. Historically, this criteria has been satisfied, but recently there have been questions about whether it remains the case in today's environment. Inexperienced pilots have been flying at very low rates—rates so low in some operational units that, as discussed in Chapter Two, IPs have expressed concern that inexperienced pilots are merely maintaining their basic flying skills and do not have the opportunity to learn more advanced skills. Moreover, much of the flying that has been accomplished during contingency deployments may have less training value per flying hour than traditional home-station training.

The pre-RDTM definition of an experienced pilot was based on active rated service and imposed no conditions either on total flying hours or on the type of aircraft flown. The sole requirement was five years of active rated service, which happened to coincide with the ADSC in effect at that time. A pilot was thus deemed experienced in the pre-RDTM period if he (there were no female pilots at the time) was serving on active duty voluntarily irrespective of any actual flying background, previous assignments, or relevant operational knowledge. Again, changing attitudes and policies during the hostilities in Southeast Asia may account for this apparent anomaly. At the outset of these hostilities, fighter pilots entering combat averaged more than 1000 hours each, whereas their average had dropped below 250 hours by the end of the war.

Prior to the implementation of the Aviation Career Incentive Pay (ACIP) program in 1974, there were no nonflying assignments per se. All pilots were required to fly for pay and proficiency regardless of the nature of their assignments, and proficiency-flying options were provided as necessary. Pilots thus continued to accumulate flying hours (and related experience) wherever their assignments took them.

The five-year requirement was probably adequate to ensure that every pilot had at least one assignment that stressed operational mission demands rather than proficiency issues only. Also, the distinction between the two types of flying was less clear in many MWS

communities before the revolution in operational training that occurred during the 1970s.[20]

Experience Level

The *experience level* establishes the proportion of experienced pilots in a particular pilot population. Experience levels were recognized under RDTM as an important indicator of unit readiness and combat capability. Moreover, we have just confirmed that such levels are also an important component governing the dynamic behavior of the flow of new pilots into a weapon system. In a sense, experience level measures the proportion of absorbable billets in a given population that are not (or cannot be) filled by inexperienced pilots.

Experience level is an extremely important parameter in operational units because it governs how the available training sorties can be distributed among pilots. It has long been recognized that inexperienced pilots, who typically *require* supervision, need more training than do experienced pilots, who typically *provide* supervision. This distribution of sorties is not attainable at any experience level in actual units because of in-flight supervisory demands, but for units with experience levels of 60 percent or above, sorties can be distributed uniformly among the pilots in the unit. If experienced pilots represent a lower proportion of the total, however, they must individually fly a disproportionately greater share of the available sorties in order to ensure that adequate supervision is provided. These effects are primary findings in our earlier work, which documents the increase in sorties required to offset decreasing unit experience levels. The document also includes charts depicting sortie and aging rate degradations as functions of unit experience level. These are important considerations as units endeavor to meet ongoing upgrade demands and to accomplish their respective mission taskings.

[20]See Anderegg, 2001, p. 40, and the references cited therein for flying hour data. The book chronicles events in the training revolution. One could probably conclude that pilots flew many more hours per month before the training revolution began, but they definitely received less training per hour and probably less training per month than was subsequently the case. Proficiency flying ended formally when Congress passed the Aviation Career Incentive Pay Act of 1974, although it was effectively terminated by executive order in the spring of 1971.

Experience level also has a significant effect on the quality of training per available sortie that the unit is able to accomplish.[21]

These factors mean that the experience level parameter also provides an important management tool for entire MWS categories. This was yet another major contribution of the RDTM paradigm. For the first time, the Air Force began to use overall experience level objectives within an MWS category to manage the distribution of newly produced pilots to specific operational units. The issue that has yet to be resolved, however, is exactly how experience levels should be calculated for specific pilot populations.

Calculating Experience Levels

The meaningful experience level value for operational units measures the proportion of primary mission (i.e., API-1) pilots who are experienced. The API-6 staff and supervisory billets that are assigned or attached to a squadron should be filled with experienced pilots, so they should not figure into experience level calculations unless these positions are not filled and the unit is undermanned.[22] The API-1 proportion is the meaningful value for our model calculations as well as for the squadron schedulers who need to build flying schedules that ensure the availability of adequate in-flight supervision.

Unfortunately, the assignment system sends pilots to wings, not squadrons, so it has no control over which pilots will be assigned to API-1 billets and which to API-6. Wing and group commanders quite correctly maintain control over these assignments. The system does remain fully aware of the total number of experienced pilots that it sends to a wing, but the extended lead times associated with the training pipeline require that it make forecasts concerning future experience levels. These forecasts in turn require assumptions on how the API assignments will eventually break down. To ensure that the

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[21]See Taylor et al., 2000, pp. 19 and 21, for the referenced charts. The work also confirms the fact that inexperienced pilots can never actually fly more sorties on average than experienced ones while also confirming the 60 percent experience level cutoff below which a unit cannot distribute its sorties uniformly.

[22]Operational flying is scheduled, managed, and conducted within squadrons. Therefore, overhead pilots assigned at the group or wing level must be attached to a squadron for flying purposes.

experienced pilots assigned will fill all of the API-6 authorizations, these billets are subtracted from the number of experienced pilots projected in the unit to yield the experienced portion of the assigned pilot population. The "official" experience level is then calculated by dividing by the number of API-1 *authorizations* because the future API-1 assignments are not available to the assignment community. AFI 11-412 provides two experience formulas, both of which suffer from the problem of mixing spaces with faces:

$$\text{Wing experience level} = \frac{\text{Experienced pilots assigned} - \text{API-6 authorizations}}{\text{API-1 authorizations}} \tag{4.1}$$

$$\text{Squadron experience level} = \frac{\text{API-1 experienced pilots assigned}}{\text{API-1 authorizations}} \tag{4.2}$$

Both of these equations make the assumption that manning will stay at 100 percent (i.e., that the number of assigned pilots is exactly the same as the number of authorizations). Equation (4.1) reflects the actual experience level for a wing only when it is manned at exactly 100 percent for both API-1 and API-6 pilots. The primary problem is that the denominator, which should express the actual number of API-1 pilots assigned, is in error when actual manning deviates from authorizations. If the wing is undermanned in API-1 pilots, Eq. (4.1) underestimates its actual experience level, whereas the equation overestimates the experience level of a wing that is overmanned. Similarly, Eq. (4.2) provides an accurate squadron measure only when that squadron is manned at exactly 100 percent.[23] We need to stress that neither of these formulas accurately exhibits the experience issues that were developed in our earlier work, especially when units are overmanned.[24] The key ratio in useful experience level

[23]The behavior of the errors in the estimate is reversed if the denominator in the equation uses the expression (total pilots assigned – API-6 authorizations) to estimate the number of API-1 pilots actually assigned. This option was rejected in favor of the formula shown. This may reflect a natural bias in assignment system evaluation methods against a failure to fill all of the authorized billets. The API-6 billets can also fail to be properly manned, but if the sum of the two types of authorizations is manned accurately, this reflects a local problem in distributing the available pilots.

[24]See Taylor et al., 2000.

calculations is the number of experienced API-1 pilots assigned divided by the total number of API-1 pilots assigned—for squadron as well as aggregated calculations for weapon systems or MWS categories. We must use:

$$\text{ExpLevel} = \frac{\text{Experienced API-1 assigned}}{\text{API-1 assigned}} \tag{4.3}$$

to avoid errors as manning levels vary.

The aircrew management successes that followed the implementation of RDTM kept units manned at levels very near 100 percent for more than two decades (FY 1978 through FY 1998), and it became commonplace for Eq. (4.1) to be used to report actual conditions as well as to make forecasts. Unfortunately, provisions were never made to aggregate the data required to calculate actual API-1 experience levels for MDS communities and MWS categories. This is what caused inaccurate experience levels to be reported in FY 2000 at Pope Air Force Base, for example, and the magnitude and effects of these errors were not fully recognized by appropriate staff members until the resulting problems had become quite severe. The Air Force is currently addressing these issues, but it is not clear that accurate experience information consistently reaches decisionmakers in all cases.[25]

Finally, pilot shortfalls coupled with low experience levels can lead to circumstances in which pilots who are technically experienced but cannot immediately become flight leads or aircraft commanders are more likely to be assigned to operational units. Typically, these pilots were previously qualified in an obsolescent airframe from the same MWS category (such as the F-4 or F-111 in fighters) and have served several intervening staff or other nonoperational assignments. Such pilots improve experience levels only on paper because they do not improve the unit's ability to cope with problems resulting from low experience.

[25]There are other examples in which the system has confused programming values with actual values for key parameters, thereby providing decisionmakers with erroneous information. We will see in the next section that flying hours historically have provided multiple opportunities for misinterpretation.

This discussion exhibits another key factor that can limit the quantity of training available to individual pilots. It should be clear that the manning level of an operational unit can have a significant effect on its experience level.

Manning Level

Manning level is another important parameter that influences a unit's ability to manage the training opportunities that are available to its pilots. This parameter measures the ratio of assigned pilots to authorized pilots. At the squadron level, the most meaningful ratio involves primary mission pilots (i.e., API-1 pilots assigned divided by API-1 authorizations) because the two API-6 authorizations are extremely likely to be filled exactly. At the wing level, primary mission pilots still represent the most important manning-level concern, but it may prove useful to examine the API-6 ratio as well because wing and group commanders have the flexibility to make adjustments in both categories when manning levels deviate from 100 percent.

Adverse effects on unit training and readiness occur when deviations in either direction (i.e., manning levels above or below 100 percent) become excessive.[26] It is clear that when inadequate numbers of pilots are assigned, units could have difficulty meeting combat tasking levels. Undermanning could also prevent units from developing adequate numbers of new pilots who are qualified to maintain a pilot mix sufficient to the conduct of mission-essential training.

Deviations that take manning levels above 100 percent, however, can also cause serious training problems. A unit with an excessive number of assigned pilots must distribute its limited training resources among these pilots, ensuring that each pilot receives less training than would have been available at a lower manning level. We will later establish conditions in which high manning and low experience levels are likely to occur simultaneously and seriously impair training options. At this point, however, we will simply provide historical evidence confirming that this combination can generate serious con-

[26]At the squadron level, any deviation exceeding three pilots in either direction can become problematic. Three pilots represent about 10 percent of a typical squadron's API-1 authorization. Deviations that exceed 15 percent in either direction for any aggregation of units would definitely generate concerns.

cerns with regard to readiness and combat capability. In documents that characterize the post-Vietnam aircrew management problems that generated the paradigm shift to the RDTM system, for example, both high manning levels and low experience levels are identified as primary causes. Indeed, the Tactical Air Command's (TAC's) Director of Personnel sent a message in October 1974 containing the following statement: "[The] combat capability of F-4 units is of continuing concern to TAC/DO/DP. All operational F-4 units are currently experiencing high manning/low experience levels."

The message goes on to make it clear with data that the second sentence states the fundamental reasons for the concern expressed in the first. Also included in the data is the information that the wing with the greatest problem at that time had a manning level near 120 percent and an experience level (using the 5-year active rated service criterion) below 30 percent. It may also be worthwhile to observe that very similar manning and experience conditions contributed to the adverse training circumstances that we documented at Pope Air Force Base in July 2000.[27]

CALCULATING THE RATE AT WHICH PILOTS BECOME EXPERIENCED

We will next turn to the calculations required to determine how many pilots can become experienced each year. This *experience rate* factor was introduced earlier and depends in a crucial way on the *aging rate* for new pilots, which is the monthly rate at which new pilots gain experience. The aging rate, in turn, is a fairly complex function of several other parameters. Although many of these parameters may be somewhat familiar, we will show that opportunities still exist for them to be misinterpreted. We begin the discussion with a unit's training capacity.

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[27]The message quoted is HQ TAC/DP, TAC/DP 211820Z, October 1974. TAC was the Cold War predecessor of ACC. Almost all fighter units were equipped with F-4 aircraft in 1974. "TAC/DO" in the message text refers to the TAC Director of Operations and TAC/DP to the TAC Director of Personnel. The manning and experience levels cited refer to primary mission (API-1) pilots only. Actual experience levels increased significantly (to above 40 percent) when the new definition was applied. The ACC staff (ACC/DOT) provided the actual historical documents.

Training Capacity

An operational unit's *training capacity* (TngCapacity) is the total number of sorties available each month that the unit is able to fly. This sortie total is a function of a unit's PAA and UTE-rate parameters.

The *PAA* parameter, which identifies the number of primary aircraft that a unit is authorized to possess, was previously encountered in our discussions of pilot requirements and absorbable billets because the number of API-1 pilot authorizations for any unit is determined by multiplying the appropriate CR by the PAA. The PAA is closely related to another parameter, called the *primary mission aircraft inventory* (PMAI), that is also associated with operational units. Careful management of *backup aircraft inventory* (BAI) and *attrition reserve* (AR) aircraft is required for the Air Force to maintain an acceptable balance between unit aircraft authorizations and inventories. All units lose aircraft from their inventories and must balance these losses using BAI and AR adjustments. These losses can be permanent or long term, depending on whether they are caused by attrition or by off-station maintenance and modification needs.[28]

The *UTE rate* is defined (for fighters) as the number of sorties per authorized airframe per month that the unit can fly. Thus, the training capacity, or the sortie total available to any operational unit, is given by

$$\text{TngCapacity} = \text{UTE} \times \text{PAA} \tag{4.4}$$

It will be important to distinguish between the programmed UTE rate (a planning figure) and the actual UTE rate. In the late 1990s, actual UTE rates for fighters dropped well below programmed UTE rates, resulting in lowered training capacities. This drop was caused by a combination of factors that included funding issues, depot maintenance problems, maintenance manning difficulties, parts supply problems, and aging aircraft.

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[28]See Department of the Air Force, AFI 11-401, *Flight Management*, October 1, 2001, for more information on these relationships.

Sorties Available to API-1 Pilots

Each squadron's available sorties must be shared between its assigned API-1 pilots and its assigned and attached API-6 pilots. Again, because API-6 pilots should always be experienced, only the API-1 portion of the unit's training capacity contributes to the process of turning inexperienced pilots into experienced ones. Every squadron has exactly two internal API-6 authorizations, but the number of attached API-6, or *overhead*, pilots varies among squadrons depending on the characteristics of the parent wing or group to which the squadrons belong. Parent units containing fewer squadrons, for example, generally require more overhead pilots per squadron, and parent units with mixed-aircraft MDS configurations impose larger overhead flying burdens on its squadrons than do more traditional single-MDS units. Clearly, when training resources remain fixed, increasing the overhead burden on any squadron reduces the sorties available to API-1 pilots.

It should also be clear that lower-PAA squadrons will have fewer API-1 pilots than higher-PAA squadrons because the API-1 pilot authorization of the former is given by their CR multiplied by their PAA. Thus, for a fixed overhead pilot burden, lower-PAA squadrons must devote smaller proportions of their sortie training capacity to API-1 pilots than higher-PAA squadrons because training capacity also varies directly with PAA. In particular, the move from 24-PAA to 18-PAA squadrons that accompanied the 1990s drawdown led to marked decreases in the proportion of training sorties available to API-1 pilots throughout the active fighter force.

Throughout this report, we have used ACC programming values for both assigned and overhead API-6 sorties. These values are calculated unit by unit to accommodate the variations we have just described, but the allocation assumes that these pilots fly at essentially the minimum rates required to maintain their mission qualifications. The available API-1 sorties are then calculated by subtracting the API-6 sorties from the total training capacity.[29] We will see that this value probably underestimates the sorties flown by these pilots and

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[29]These programmed values provide an overall average for active fighter units of about seven sorties per authorized overhead pilot per month (to maintain BMC status) and roughly nine sorties per month per assigned API-6 pilot (to maintain CMR status).

provides a highly optimistic estimate of the sorties available to API-1 pilots—especially as experience levels drop—because of the in-flight supervision that inexperienced pilots require.

Average Sortie Duration

To convert numbers of sorties into numbers of flying hours, we use a factor called average sortie duration (ASD). This parameter applies only to fighter aircraft, as all other major weapon systems measure their activity directly in hours.

Once again, it is important to distinguish between programmed and actual values. If a unit deploys to Operation Northern or Southern Watch, for example, the flights in the area of responsibility (AOR) may involve several air refuelings and will thus be many times longer than the programmed ASD. Aircraft may be stationed relatively far from the AOR, so patrol flights can be quite long. The key issue is whether increases in ASD correspond to proportionate increases in training. Typically they do not. Recent Operation Noble Eagle combat air patrol (CAP) flights supporting homeland security provide additional examples of flights in which the training received per hour is definitely degraded in comparison to normal home-station training standards.

Still, for a fixed set of circumstances, it is convenient to be able to move back and forth between sorties and hours using average ASD values as appropriate.

Sorties and Hours per Crew per Month

We can use the API-1 portion of the training capacity (API-1 sorties) and the number of API-1 pilots assigned to calculate the average number of *sorties per crew per month* (SCM) that are available for API-1 pilots to fly. We can then use the appropriate ASD value to calculate the average number of hours these pilots can fly each month. Even though new pilots may gain flying hours at significantly disparate rates, we want to develop the factors that govern the average or typical behavior of the pilots in a unit, weapon system, MWS category, or other aggregation so that we can develop models that replicate this behavior. Our immediate objective is to calculate how long

it takes to turn new pilots into experienced ones. This, in turn, helps us estimate the total number of inexperienced pilots as well as the rate at which these pilots will on average become experienced. This average flying hour accumulation is typically measured by a parameter that the Air Force calls *hours per crew per month*, or HCM. This term can be applied in several contexts, however, and it will be useful to understand these distinctions. First, we will restrict our attention primarily to API-1 averages because of our interest in inexperienced pilots. The values that primarily interest us are given by

$$\mathrm{SCM} = \frac{\text{API-1 sorties}}{\text{API-1 assigned}} \tag{4.5}$$

and

$$\mathrm{HCM} = \mathrm{SCM} \times \mathrm{ASD} \tag{4.6}$$

We must continue to distinguish between *programmed* and *actual* HCM values. Historically, the HCM measure was developed as a programmatic indicator to examine the effects of actions taken within the planning, programming, and budgeting system (PPBS) process. This was motivated by events in the 1970s, when rising fuel costs and domestic pressure on the defense budget initially made flying time a serious budgetary issue. Previously, available flying hours had rarely imposed a training constraint on Air Force units. Programmed HCM is based only on aircrew authorizations and is never adjusted for manning or experience level concerns. Actual HCM, on the other hand, should measure the actual hours flown each month by the assigned pilots and definitely depends on manning levels.

The historical methods that have been used to calculate this measure, however, have typically been flawed. Prior to 1990, for example, pilot authorizations, not assigned pilots, were divided into monthly flying hour values to calculate the "actual" HCM average. Prior to 1993, the flying hour values were taken from maintenance records that tallied aircraft hours, not aircrew hours, and the breakdown by aircrew position indicator was estimated rather than calculated. Even though the Air Force Operations Resource Management System (AFORMS) database has been used since 1994 to provide flying hours by API designation and average numbers of assigned

pilots, much useful information can still be lost in the averaging process.[30]

It is interesting to note that TAC began tracking actual HCM values in the late 1970s as part of an initiative by General Wilbur Creech, then the TAC commander, to improve operational training for line pilots. This initiative generated an annual increase of approximately 5 percent in actual HCM each year from FY 1981 through FY 1985, and it may have marked the first instance in which programmers and decisionmakers fully recognized the distinction between programmed and actual HCM values.[31]

We will discover that glaring errors result when either programmed or actual HCM values are used to estimate the rate at which new pilots are flying. The latter value fails to incorporate the reduced training available to inexperienced pilots because of their need for in-flight supervision, and the former value makes the additional assumptions that the flying hour program can be flown out unit by unit and that units are never overmanned. This brings us to the next parameter.

Aging Rate

The *aging rate* is given by the hours that are actually flown on average per month by inexperienced pilots. It must be obtained by separating the actual HCM values into the respective portions flown by inexperienced and experienced pilots. This process must account for the reduced flying opportunity available to new pilots who do not have the knowledge and experience required to fly as flight leads or aircraft commanders. An approach toward achieving this was a primary topic in our earlier work, where we confirmed that aging rates for pilots in notional fighter units depend on the units' experience

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[30]The actual availability of assigned pilots to fly, for example, is always lost in the averaging process.

[31]The information in this paragraph is taken primarily from Air Staff documents prepared to support Corona Top 2000. See HQ USAF/XOOT, bullet background paper, April 2000, *Actual Hours per Crew per Month*, and its attachments, plus HQ USAF/XO, *Corona Top, Active Duty Actual Hours/Crew/Month (HCM)*, briefing, June 2000. The historical perspective on training constraints imposed by flying hours and the actions taken to improve training in the late 1970s are also documented in Anderegg, 2001.

levels as well as on their actual HCM flown on average. Graphical depictions of these relationships are given in that document.[32]

ACC implemented a new initiative in FY 2000 to collect data capturing the actual HCM by MWS category for inexperienced pilots. While it is true that aging rate and inexperienced HCM are different names for the same parameter value, recording inexperienced HCM data is only an important first step in documenting actual aging rate data in order to test the validity of our model estimates. This is because the corresponding unit experience levels that produce the actual inexperienced HCM data are not being recorded. It is also likely that any experience levels that might be available in other data banks have been calculated using pilot authorizations instead of pilots assigned, as exhibited in Eq. (4.1). It will be essential to have experience level data as well as the aging rate (or inexperienced pilot HCM data) in order to test our model results and obtain the accurate historical aging rate information that is essential for estimating *future* aging rates, which have an important programmatic function in setting production rate quotas.

Time to Experience and the Number of Inexperienced Pilots

Future aging rates are vital to the programmatic process because they determine the time period required for inexperienced pilots to become experienced. This parameter is called the *time to experience* (TTE) and is given by

$$\mathrm{TTE} = \frac{\mathrm{HoursExp}}{\mathrm{AgingRate}} \tag{4.7}$$

where *HoursExp* denotes the remaining PMAI hours required to become experienced.[33] A related parameter is the average *time on station* (TOS) that pilots spend at their initial operational assignment. The TOS parameter can depend on the nature of the assignment. Overseas assignments, for example, are typically of a fixed length,

[32]See Taylor et al., 2000, pp. 19–21.

[33]Hours flown during FTU B-Course training (normally about 80 hours in fighters) will count toward the PMAI hours required to become experienced.

whereas CONUS assignments vary depending on other assignment demands. For our purposes, we interpret TOS as the point at which pilots leave operational flying to perform other duties. It is important that TOS exceed TTE values on average for CONUS units if one is to avoid sending inexperienced pilots to fill billets that require experienced ones, so steady-state analyses typically regard TTE as a lower bound for an acceptable TOS level.[34]

We can use the TTE value to estimate the total number of inexperienced pilots in a specific pilot population for a steady-state situation as long as we account for the dynamic element that this parameter introduces. If the TTE is not excessive, the number of inexperienced pilots in the population will be given by

$$\text{InExp} = \text{ProdRate} \times \text{TTE if TTE} \leq \text{TOS} \tag{4.8}$$

If TTE does exceed the available time that pilots can remain in the population, the assignment system cannot flow in an acceptable manner because inexperienced pilots who exit operational flying billets before they become experienced are not qualified to fill alternative fighter requirements.

Experience Rate

The number of pilots who become experienced, or the *experience rate*, can now be calculated as follows:

$$\text{ExpRate} = \frac{\text{InExp}}{\text{TTE}} \text{ if TTE} \leq \text{TOS} \tag{4.9}$$

where the TTE constraint is necessary to ensure that the pilots actually do become experienced.

[34]Although TOS is the standard terminology, it can sometimes be misleading. We will see that when we aggregate the operational API-1 billets for a weapon system or MWS category, a more critical measure may be the time available on average for inexperienced pilots to remain in operational units. The key issue is that no system can reach an acceptable steady state if TTE values become excessive.

The expected value of future experience levels can then be estimated if the remaining population billets can be exactly filled with experienced pilots. This estimate is given by

$$\text{ExpLevel} = \frac{\text{API-1 assigned} - \text{InExp}}{\text{API-1 assigned}} \tag{4.10}$$

Before we use these relationships to express the precise definitions associated with absorption capacity, we need to examine the problems associated with historical efforts to forecast the required parameter values.

FORECAST AND ACTUAL VALUES

Production rate quotas can require long lead times to achieve,[35] and there is a definite need to estimate future aging rate and experience level values that will result from production changes. Currently, however, no accepted method is available for calculating programmed aging-rate values. Indeed, we know of no effort to quantify the differences between aging rate and HCM until our earlier work in this area became available.[36] Until 1999, the programmed HCM value was typically used in the programmatic process to estimate TTE and expected experience levels. This is the wrong value to use for this purpose because programmed HCM overestimates the hours inexperienced pilots can average each month and leads to optimistic TTE and experience level values.

Programmed HCM Is an Optimistic Aging Rate Estimate

First, even if the programmed hours are actually flown in aggregate, the programmed HCM will not accurately represent the aging rate because of manning and experience issues. Indeed, our previous

[35]The production-rate quotas set by the 1996 Four-Star Rated Summit were never achieved. Those set at the 1999 summit were programmed to occur in FY 2002, but it now appears that they will not be fully implemented until FY 2003. Constraints on pipeline capacity in both UFT and FTU training programs are the primary causes for the delays.

[36]Documented in Taylor et al., 2000.

discussions confirm that programmed HCM accurately represents aging rates only for units that meet three highly restrictive criteria. For new pilots to age at programmed HCM rates, units must

1. Fully fly their programmed flying hours;
2. Be manned at exactly 100 percent of their authorized pilot strength; and
3. Have experience levels that exceed 60 percent.

Very few units have met all three of these conditions simultaneously over the past decade. Moreover, historical evidence indicates that programmed flying hours are never fully flown in aggregate. This is true in virtually every weapon system category, but the effects are more evident in fighters than in other MWS categories that may have access to alternative flying hour options.[37]

The budget process has evolved to the point at which programmed hours represent an absolute upper bound for the number of hours that can be flown each year in fighters. Units cannot exceed programmed hours in aggregate because funds for additional hours have been capped. Indeed, the funds are often exhausted before the hours can be flown out because the actual cost of fuel and other consumable items exceeds the original programmed per-hour charges. Even when funds and flying hours are available, however, fighter units have in recent years had difficulty generating requisite numbers of training sorties. These difficulties are the result of aircraft

[37]Alternative flying hour sources include contingency hours that are normally funded after the fact by separate congressional authority and hours that are funded by the Transportation Working Capital Fund (TWCF), which supports the movement of significant quantities of government personnel and equipment. The tanker and airlift categories regularly benefit from TWCF hours, and the additional hours flown in this mode continue to provide training and experience for the pilots. Although fighters are typically tasked when national contingency operations are required and the pilots continue to gain experience in these operations, previous congressional funding delays have caused the Air Force to require that units fly programmed hours in support of these contingencies until the hours are exhausted. This means that for the most part, these hours are flown in place of normal programmed training hours and thus do not appreciably increase aging rates. Indeed, the regular contingency support that has occurred over the last decade to enforce no-fly zones over Iraq often impedes upgrade opportunities for new pilots and slows their development into experienced pilots. Also, these contingencies must often be supported by split flying operations that degrade home-station training opportunities.

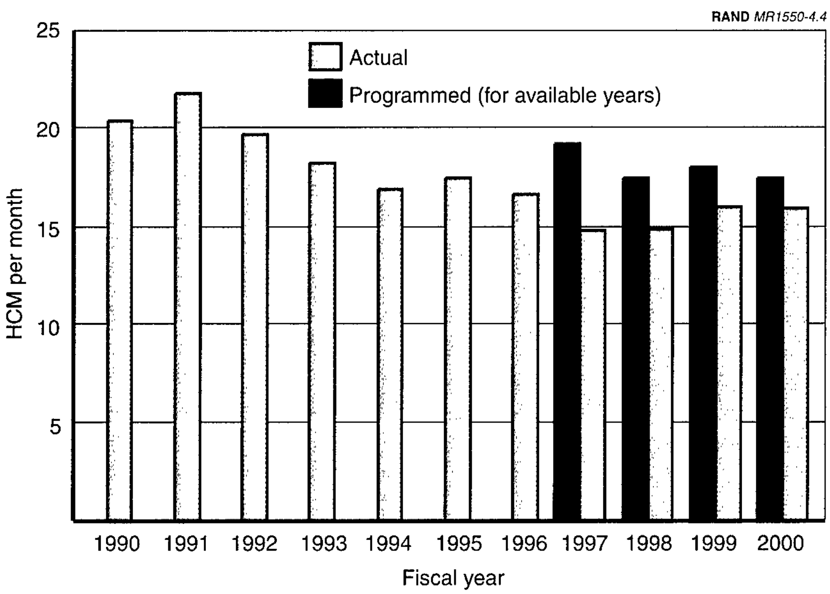

Figure 4.4—Actual HCM for API-1 Pilots in Fighter Units Trended Downward and Failed to Meet Program Objectives

utilization problems that have been exacerbated by aging aircraft, parts shortages, reduced funding, maintenance problems, split operations, and other issues. These factors have combined to ensure that actual HCM remains well below the programmed HCM value for primary mission (API-1) pilots in operational fighter units. As shown in Figure 4.3, these results have not been encouraging for the fighter MWS category over the past decade.

Actual HCM values have been trending downward throughout most of the decade, and programmed HCM values also exhibit downward trends during the years for which data are available. It is important to recognize that pilots have been unable to fly the programmed HCM despite a significant effort within the Combat Air Forces (CAF) to increase aircraft UTE rates for fighters that began in FY 2000. Decisionmakers now recognize that it is critical to fully fund and fly the flying hour program, but this may not help the aging rates for new pilots unless the effects of other parameters are also accounted for. Fighter aircraft UTE rates, for example, increased from 16.3 sor-

ties per airframe per month in FY 1999 to 17.7 (in the aggregate) in FY 2000, yet Figure 4.4 clearly shows that there was no accompanying increase in the actual HCM average for primary mission pilots. This disparity was caused by overmanning problems that operational fighter units experienced in FY 2000 as well as by sortie distribution issues that caused more of the available sorties to be flown by overhead (API-6) pilots in order to meet supervisory needs. The situation is even more discouraging when we examine the HCM data for inexperienced pilots that units started reporting in FY 2000. During the 18-month period that includes FY 2000 and the first half of FY 2001, for example, inexperienced A-10 API-1 pilots averaged about 13 hours each month compared to a programmed HCM value of about 19. When we compare this result to the hours flown by inexperienced pilots at Pope Air Force Base, first discussed in Chapter Two, we can also appreciate the amount of information that can be lost in the averaging and aggregation process. It is important to note that lost information of this type may never reach decisionmakers.[38]

Aging rates represent the key parameter developed in this section, but there is a high potential for the precise interrelationships among the associated parameters to be confused. It may help avoid confusion if we review some of the issues and relationships that will pertain in our subsequent discussion.

Summary of Aging Rate Issues and Related Parameters

As depicted in Figure 4.1, the pool of aircraft sorties available to a given operational squadron is determined by its PAA together with its actual (monthly) aircraft UTE rate.[39] This pool represents the unit's total monthly training resources and is simply the product of these

[38]A-10 units had the most significant overmanning problem from FY 2000 to FY 2001, but other MDSs were also affected, with the next-largest effect in F-15s. Data in this paragraph (including Figure 4.3) are from the Air Staff (AF/XOOT) and the ACC Staff (ACC/DOTB).

[39]The need to track both sorties and hours applies only to fighter units. Other MDSs measure both training needs and aircraft utilization in terms of aircraft hours, rather than aircraft sorties. Sorties, however, definitely represent the appropriate incremental training unit for fighters, but hours remain essential to determining when pilots become experienced. Other weapon systems are similarly affected, but all of the issues seem to resonate most noticeably in fighter units.

two parameters. The sortie pool itself is constrained in the current environment by a number of factors. These include aging aircraft, parts shortages and other exigencies that were caused by a number of years of inadequate funding, low experience levels in maintenance organizations, and heavy deployment tasking that leads to split operations and reduced home-station training options. As mentioned previously, Air Force leadership has recognized the need for units to increase aircraft UTE rates so that in aggregate they can fly the flying hour program. For most of the analysis that we are documenting here, we are willing to make the assumption that *these planned UTE rate increases will occur exactly as programmed.* We will point out some of the consequences of not meeting this assumption, however, and will conduct excursions that use current data instead of programmed results or that more clearly exhibit the problems that could result if programmed values are not attained.

The distribution of available training sorties is another important factor in determining the aging rates for new pilots in a given unit. The first sortie distribution issue is how sorties break out between primary mission (API-1) pilots and overhead (API-6) pilots. Except for qualitative discussions, our analysis will use current ACC methodology to shred the sorties between these two groups.[40] The pool of available sorties rarely changes as the unit's pilot manning level increases, however, so that actual HCM values for overmanned units can fall short of programmed HCM values even when aircraft UTE rates meet programmed levels. This effect has never been recognized in existing Air Force steady-state RDTM models, but manning levels are an essential component in any analysis that seeks to determine appropriate production rates. Actual HCM data, however, still do not yield actual aging rates. The final sortie distribution factor required to determine aging rates is how the sorties are split between experienced and inexperienced pilots in a unit. This factor has also been omitted from most Air Force steady-state analyses. The initiative to begin tracking actual HCM values for inexperienced pilots that was implemented in FY 2000 could help analysts estimate

[40]Requirements also exist to support above-wing staff (API-8) pilots, but their sortie needs are small and will be ignored. A potentially more significant problem is represented by the sorties required to support the flying needs of O-6s and above because they often require IP assistance, but this requirement is also ignored in our analysis.

aging rates on the basis of historical information, but the problem with information lost in aggregation will remain unresolved.

STEADY-STATE CONDITIONS AND MAXIMUM ABSORPTION

The equations in the preceding section provide the information necessary to define exactly what is meant when we discuss steady-state analyses. If TTE is not excessive and the pertinent parameter values remain constant over time, we can substitute Eq. (4.8) into Eq. (4.9) to obtain

$$\text{ExpRate} = \frac{\text{ProdRate} \times \text{TTE}}{\text{TTE}} = \text{ProdRate} \qquad (4.11)$$

for a steady-state situation. Indeed, we will use the equilibrium condition determined when the annual production rate is equal to the experience rate as the definition of a viable steady state. When Eq. (4.11) fails to hold, the system is not operating in a steady-state environment because the parameter values are changing with time. If ExpRate exceeds ProdRate, for example, then the number of inexperienced pilots in the population is decreasing, resulting in higher experience levels, increased aging rates (until ExpLevel = 60 percent), and shorter TTEs. As long as the production rate is large enough to maintain the population inventory at required levels, these are all conditions aircrew managers can deal with because they do not stress the absorption capacity of the system.

It is when the production rate exceeds the experience rate that absorption issues become a problem, and *maximum absorption* for a weapon system population meeting specified parameters is the production rate that enables the system to operate at its maximum absorption capacity. We have just demonstrated that this occurs when a system is operating in a viable steady state, so maximum absorption capacity is the production-rate value that is equal to the experience rate achievable for the population. Absorption issues occur when a system is stressed beyond its absorption capacity. This causes changes in the key parameter values that cannot be tracked using steady-state methods. This behavior is the subject of the next chapter, in which we will also examine specific numerical excursions.

Chapter Five

ABSORPTION ISSUES AND NUMERICAL EXCURSIONS

When production rates exceed the absorption capacity for an aggregated pilot population, more inexperienced pilots enter the system each year than become experienced, and the system thus accumulates inexperienced pilots. This causes manning or experience levels (or both) to change, generating changes in other parameters as well. As the parameter values change, the system typically moves toward another equilibrium position. The new equilibrium conditions may define parameter values that stress the system. It is often instructive to conduct excursions that examine the possible values for the new equilibrium parameters in this event.

It is worth noting that the number of absorbable billets (the force structure parameter) can be a major reason a system exceeds absorption capacity. Because this parameter value typically lies outside the control of aircrew managers, however, they can only react to its effect. Historical evidence of this problem occurred during both drawdown periods in the 1970s and the 1990s. RDTM techniques resolved the problems of the 1970s primarily because adequate numbers of absorbable billets (relative to total requirements) remained available to achieve an equilibrium condition in which the other parameters would remain at acceptable values. Although this process took several years, required major Air Force innovations in aircrew training and sortie production, and necessitated the complete restructuring of what it meant to be an experienced pilot, the remaining parameter values were eventually brought to acceptable values in the 1970s. We will discover, however, that force structure limits may

be even more difficult to accommodate by adjusting the other parameters following the 1990s drawdown.[1]

There is always the potential that real-world considerations will prohibit the system from operating near the new equilibrium point. These considerations will govern our examination of absorption issues. We will take a qualitative look at this behavior before we conduct any numerical excursions.

QUALITATIVE DISCUSSION

Equations (4.3) through (4.11) provide the relationships required to conduct a qualitative examination of the absorption issues that can arise as a pilot population moves away from its equilibrium, or steady-state, behavior. We will rely on the notation in those equations for much of this discussion. A system's absorption capacity is violated when ProdRate exceeds ExpRate, and the first thing that happens is that the number of inexperienced pilots in the population increases.

This lowers the experience level, so the aging rate must drop relative to the actual HCM that the population is averaging. If the number of available sorties cannot be increased, the aging rate itself will decrease (assuming that ExpLevel is below 60 percent). Thus, unless the available sorties (or flying hours) increase, new pilots will take longer to become experienced (and TTE will thus increase). The latter circumstance will cause the disparity between ProdRate and ExpRate to become even greater. As experience levels decrease, overmanning normally occurs as well, reducing aging rates even further and exacerbating these effects.[2]

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[1]We discussed and provided references for the revolution in operational training in our historical comments in Chapter Four. Significant sortie production improvements resulted from innovations such as the production-oriented maintenance organization (POMO) and the combat-oriented maintenance organization (COMO) implemented in the 1970s.

[2]AFI 11-412 sets a wing experience level of 40 percent as the point at which overmanning becomes the preferred method of maintaining adequate numbers of experienced pilots. This experience level is calculated using Eq. (4.1), however, and overmanning often ensures that the calculated level stays above 40 percent. This is exactly what occurred at Pope Air Force Base in August 2000, when the API-1 manning level was 116.7

Parameter values that change with time are undergoing dynamic effects, and the implications of this behavior cannot be fully analyzed or understood with steady-state methods alone. Much as with aircraft systems that continue to move farther away from an equilibrium condition when perturbed are called *dynamically unstable*, and if left unchecked this behavior has the potential for detrimental consequences for the operational units included in the system under review. An approach that explains these dynamic issues thus becomes essential.

A critical dynamic issue is the relationship between the increasing TTE and the average TOS. If TTE increases to the point at which it exceeds TOS, Eqs. (4.8) and (4.9) are no longer valid. This means that the system is now losing pilots while they are still inexperienced without any deliberate aircrew management decision to do so. The experience rate for these pilots can no longer be calculated using Eq. (4.9) because their TTE has become excessive, and a viable equilibrium condition may not exist in these circumstances.[3]

The dynamic interrelationships among these parameters are responsible for many of the unintended consequences of policy decisions that are too narrowly focused. The conditions we observed during our site visit to Pope Air Force Base provide an example. We can exhibit the complexities that underlie these problems more effectively by examining some quantitative results. We will prepare for this discussion by developing a BCS for a number of parameter values.

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percent and the API-6 manning level was 125 percent, reported experience was 48.6 percent, while actual API-1 experience was only 36.9 percent.

[3]A number of pilots continue their operational flying at the end of their initial tour. Normally this occurs when one of the operational tours is remote. Both our static and our dynamic models account for the abbreviated TOS for pilots in initial overseas short-tour assignments because such pilots continue to gain experience during follow-on assignments in normal units. Thus, the applicable TOS for these pilots pertains to their follow-on assignments. Unfortunately, most pilots whose second tour is remote leave the first unit sooner than the average TOS; only a limited number of pilots are able to receive follow-on operational assignments to nonremote locations. Thus, most pilots need to become experienced during this "initial assignment sequence." Our discussions often assume that pilots remain in the system under review throughout this period.

BCS Parameter Values For Fighter Absorption

We should stress from the outset that this scenario is identified as a "best case" only in terms of its associated absorption capacity. We will take these parameter values from three primary sources and will amplify the extent to which they represent a best case in the subsequent discussion. The sources are as follows:

1. Values that were set by Air Force leaders at the June 2001 Four-Star Rated Summit.
2. Values based on goals that have been agreed on, but not yet necessarily been achieved by Air Force programmers.
3. Values that have been set by staff analysts as representative of aggregate, unit, or individual behavior.

We will summarize the parameter values in Table 5.1 after the development is complete. Later we will conduct excursions on some of these parameters as appropriate.

The 2001 Four-Star Rated Summit reconfirmed the production rates of 1100 total pilots and 330 fighter pilots that were set previously by the 1999 Rated Summit. The new summit also confirmed several related changes, including a major revision of the 1999 decision to send 30 of the new fighter pilots to guard and reserve units to become experienced as well as an increase in the number of fighter FAIPs from 60 to 75. The new summit also tacitly endorsed a reduced experience level objective.[4]

In FY 2001, ACC took the lead to increase the flying hours available to its fighter units for operational training by reestablishing standardized aircraft UTE rates for the first time since new training directives were implemented in July 1997. The other two active commands in the CAF,[5] although reluctant to concur immediately, eventually

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[4]We use the term *tacitly* here because staff agencies had recognized well before the 2001 summit that a 55 to 60 percent goal was not attainable; decisionmakers had responded by setting 50 percent as the "minimum," with 45 percent as the "absolute minimum." We will see when we look at our quantitative results that the desired combination of production and experience objectives still remain mutually unattainable.

[5]The United States Air Forces in Europe (USAFE) and the Pacific Air Forces (PACAF).

agreed to begin increasing UTE rates in FY 2002 in an effort to start flying out the programmed annual flying hours.[6] These ACC objectives currently represent the evolving long-term goals.

These UTE rates, coupled with several additional parameter assumptions, will fix the values of the HCM objectives for API-1 pilots in each of the MWS categories. The resulting monthly sortie pools can be calculated by multiplying these UTE rates by unit PAA. We will use standard planning-factor assumptions to divide these sortie pools into API-1 and API-6 sorties for the units involved. Standard average sortie duration factors (based on historical data) can then be used to convert these sorties into monthly flying hours available for training (by API category). We next divide the available flying hours by the respective authorized billets (equivalent to assuming that all units are manned at exactly 100 percent) to convert them into programmed HCM values for the API-1 pilots (as well as the API-6s). All of the parameter results are summarized in Table 5.1.

Underlying Training Capacity and Aging-Rate Assumptions

Additional parameter values are based on a number of underlying assumptions, all of which deal specifically with the training capacity and aging rates that will be available in fighter units. The following list summarizes the assumptions that have been made:

- Flying hour programs for FY 2002 and beyond are fully funded and flown.
- UTE rate objectives are met unit by unit on the basis of FY 2002 aircraft authorizations instead of actual numbers of aircraft possessed. Thus, any reductions in effective force structure that

[6]The new training directive, called the Ready Aircrew Program (RAP), was developed to replace the graduated combat capability (GCC) program primarily to better justify the Air Force's annual flying-hour program, which was subjected to some appreciable cuts during the mid-1990s. One of RAP's provisions was to enable units to set their own desired UTE rate objectives each year. By the time it was implemented, reduced sortie generation capacity and increased unit tasking had impaired unit UTE capabilities to the point at which flying hour justifications were far less important than enabling maintenance programs to cope with these challenges.

Table 5.1

Parameters Used for Quantitative Excursions

Parameter	Assumed or Objective Value		Source
	Total	FAIPs	
Production rates			2001 summit
Total	1100	125	
Fighters	330	75	
Experience-level objective	50 percent		2001 summit
Manning-level objective	100 percent		2001 summit
Minimum TOS	Two years, eight months		ACC goal
	API-1	PAA	
Absorbable billets/cockpits			Programming documents
Total fighters	1223	923	
A/OA-10	218	128	
F-15	316	249	
F-15E	166	132	
F-16	523	414	
	UTE	ProgHCM	
UTE Rates and API-1			ACC standardized
progHCM[a]	18.5	16.8	UTE rates;
Fighter aggregate	20.7	17.6	programmed
A/OA-10	18.1	15.3	API-1 HCM
F-15	16.3	17.7	calculated from
F-15E	18.8	17.0	other parameters
F-16			

[a]ProgHCM = programmed HCM values.

result from aircraft modernization and conversion programs can be compensated for by increasing utilization for the remaining aircraft available or by another means.

- Adequate numbers of experienced pilots are available to provide units with 100 percent of API-6 and 50 percent of API-1 authorizations, and the units' only source of inexperienced pilots is the FTU basic course for the appropriate weapon system. Any other entering pilots are experienced.
- API-6 sortie allocations set by current ACC planning methods apply throughout.

Why Best Case?

We regard these parameter values as contributing to a BCS in terms of the resulting absorption capacity for several reasons. The first is that we will also assume in our quantitative examples that the UTE rates can actually be flown month over month by every active CAF unit. The next optimistic assumption is that we can use aircraft authorizations rather than inventories to calculate the available sorties. This preference for PAA over PMAI values obscures major potential reductions in effective force structure associated with two factors: (1) aircraft modifications needed to lengthen the service life of current inventory aircraft, and (2) requirements to smooth unit transitions into the F-22 and JSF.

We have also made several implicit assumptions regarding the availability of experienced pilots. Perhaps the most important of these is that there are sufficient numbers of experienced pilots available to fill out the API-1 billets to achieve a specified policy option regarding experience levels. The normal procedure would be for the assignment process to assign enough experienced pilots to the wings to fill all of the authorized API-6 billets plus 50 percent of the authorized API-1 billets (the desired experience level). This will ensure that the experience level objective is met when Eq. (4.1) is used to calculate experience level. This relates directly to another problem that makes this a BCS. In May 2001, actual experience levels in fighter units ranged from an average of 43 percent for F-16 units to 46 percent for F-15 units, and it was projected at the time that these levels would continue to drop below the 50 percent objective level. Other implied assumptions related to experienced pilots include an agreement that all pilots who arrive in operational units from any source other than an FTU B-Course either are experienced pilots or will become so during their MQT. We also assume that the assignment process is able to remove experienced pilots from operational units in the precise numbers required to maintain a prescribed manning level. Of all the experience-related assumptions, this is the one that is the most counterintuitive because experienced pilots must be removed from units precisely when unit experience levels are dropping. As we will

confirm, however, aging rate issues will dictate that units cannot afford to allow their manning levels to go far above 100 percent.[7]

The final assumptions that could turn out to be optimistic address the methods used to generate and distribute the sorties resulting from the standardized UTE rate objectives we have accepted. These UTE rates are projected for home-station flying only, but in the absence of definitive, long-term, unit-by-unit contingency support schedules, we are accepting these rates for year-round operations. We also assume that the currently programmed division of sorties between API-1 and API-6 pilots can hold up under increasingly adverse manning and experience levels. This includes agreements that the ACC-projected API-6 sortie requirements are adequate and remain constant over a fairly wide range of values for manning and experience parameters.

Our calculations, however, will adjust the programmed HCM values for overmanning conditions to estimate actual HCM values in order to calculate actual aging rates as experience levels drop. We will also conduct excursions where necessary to illustrate some of the problems that can occur if the optimistic parameter values cannot be met.

MAXIMUM ABSORPTION CAPACITY VALUES

When we couple the BCS parameter values from Table 5.1 with the desired manning level of 100 percent, our steady-state models calculate that the maximum absorption capacity of the system is 302 pilots, which is below the production-level objective of 330 pilots per year. This confirms that current Air Force objectives remain inconsistent even when viewed from a best-case perspective. When we assume that the fighter units will continue to fly at UTE rates that replicate the actual HCM values achieved by API-1s from FY 1996 through FY 2000, the maximum absorption capacity is only 285 pilots per year. This historical average provides a useful point of reference because it was flown by units whose aircraft inventory situations

[7]Data and trend information are from the HQ AF/XOO presentation *Rated Summit '01 Pilot*, given at the 2001 Four-Star Rated Summit. The experience levels computed using the formula given in Eq. (4.1), however, were very close to 50 percent and were projected to remain above 45 percent owing to aggregated MDS manning levels that remained as high as 112 percent (for the A/OA-10).

relative to unit authorizations were more favorable than those currently projected and because the figure includes contingency support operations as well as home-station flying. The UTE rates associated with the historical HCM values are some 3.84 percent below the best-case UTE rates.

NUMERICAL EXCURSIONS

Next we ask what can be changed to increase absorption capacity to 330 fighter pilots per year. These exercises rely on relationships implied by Eq. (4.11) to solve for new parameter values that will restore the balance required to establish equilibrium conditions. A number of solutions are possible, all of which involve policy decisions to determine the parameters that change to bring the system into balance. We examine several of these alternatives, comparing them to the BCS as appropriate, to determine their potential consequences. These cases include the following:

1. The BCS described above, which yields an absorption capacity of 302 pilots per year.
2. A historical default excursion that incorporates the conditions we regard as most likely to occur given historical aircrew management policies.
3. A fixed manning excursion that searches for an improved training environment by controlling the overmanning conditions resulting from the historical default.
4. An increased UTE excursion that examines the increase in sorties per authorized airframe per month required to enable both 100 percent manning-level and 50 percent experience-level objectives to be met simultaneously.
5. An increased force structure excursion that determines the force structure increase (in terms of added PAA) required to meet the manning- and experience-level objectives of 100 percent and 50 percent, respectively.

The first three cases maintain a constant training capacity. Since the BCS fails to absorb the current production goal of 330 pilots per year, the second and third cases allow manning and experience levels

within the units to vary so as to reestablish the balance. The last two excursions examine the increases in training capacity that would be required to balance the system while retaining the training environment associated with the original manning and experience objectives.

"Most Likely" Conditions: Historical Default

When production and absorption imbalances exist, the assignment process historically has attempted to maintain adequate numbers of experienced pilots in operational fighter units to ensure these units can meet the experience level objective. Equation (4.1) was used to calculate experience levels, so this means that these units require enough experienced pilots to fill their entire API-6 billet authorizations and 50 percent (the experience level objective) of the authorized API-1 billets.[8] The procedure will thus keep a constant number of experienced pilots assigned to the fighter units while greater numbers of inexperienced pilots enter these units than leave each year. Manning levels in the units will necessarily increase.

Our steady-state models confirm that a production rate of 330 pilots per year will require that manning levels exceed 125 percent in fighter units while experience levels fall to 40 percent. These conditions are similar to those we observed at Pope Air Force Base. Those values reflect some flexibility in distributing the 330-pilot production rate among the individual fighter MDSs. If we impose currently programmed fighter distribution values for each MDS, the most severe conditions occur in F-15s and F-16s, where manning levels approach 140 percent and experience levels fall below 36 percent—conditions that are worse than those we saw at Pope.[9]

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[8]AFI 11-412 identifies conditions in which units may be deliberately overmanned in an effort to provide more experienced pilots (although not necessarily higher experience levels).

[9]The MDS distribution of the 330 pilots can be adjusted to equalize the adverse conditions. The generic 125 percent manning and 40 percent experience values incorporate an adjustment of this sort. MDS-specific values are based on currently programmed distribution values. These programmed distribution values appear to limit A-10 production by increasing F-15 and F-16 production.

The degraded training environment is reflected by the fact that inexperienced F-15 or F-16 pilots average roughly seven sorties per month under these conditions. In addition to the readiness problems raised for these pilots and their units, there may be career implications for the pilots as well. The conditions drive TTE values above three and one-half years, so the ability of new pilots to become experienced in their initial operational assignment cycle becomes seriously impaired. Pilots would exit this cycle, for example, with no more than 350 to 400 hours on average in their primary mission aircraft.

Under this policy alternative, the system moves toward a nonviable equilibrium point because of the training consequences that would result if units were subjected to these conditions indefinitely. The units would definitely begin to experience conditions similar to those that prevailed at Pope at some point in time.

Steady-state analytic methods are not capable of determining how quickly these adverse training effects would occur. Our preliminary version of an improved analytic tool indicates that active F-16 units will go from current conditions to manning levels similar to those at Pope within two years once the increased flow of pilots begins to arrive in the units. The 330-pilot production level will be reached in FY 2002, so the increased flow will begin soon thereafter. It will take longer to reach experience levels similar to those at Pope because the training capacity associated with the BCS assumptions is greater than Pope could generate when we were there.

Searching for More Acceptable Equilibrium Conditions

A mathematical consequence of our work with Eq. (4.11) was our discovery that the experience level that corrects a production-absorption imbalance in a given system is independent of the manning level for the system. This means that the units in the previous example will reach equilibrium conditions at the same experience level when their manning is maintained at 100 percent as they do when their manning levels increase. Specifically, the F-15 and F-16 units discussed above must go to the same 36 percent experience level whether their manning goes to 140 percent or remains at 100 percent in order to restore the equilibrium conditions. A manning level of 100 percent does not dilute the training available in a given

unit nearly as gravely as does 140 percent manning, so we examined these conditions to see whether they might offer an acceptable alternative. This policy requires that aircrew managers deliberately remove experienced pilots from units at an earlier juncture than normal to prevent the manning level from increasing. The procedure seems nonintuitive because experienced pilots are removed from units even though experience levels are dropping.

As we discussed, this exercise establishes equilibrium conditions with the same experience levels as before while keeping the units at 100 percent manning. Thus, the generic experience level in operational units stays at 40 percent as the units struggle to absorb 330 new pilots per year. When we impose currently programmed fighter distribution values for each MDS, we also find the same 36 percent experience level for F-15 and F-16 units, but several indicators show potential improvement. Inexperienced pilots' sortie averages increase to roughly ten per month, and TTE values, although larger than those for the BCS, remain under three years. Pilots exit their initial operational assignment cycle with 475 to 520 PMAI hours, and this gap could be closed with slight adjustments in individual MDS distributions.

We do not regard these conditions as acceptable in the long term because the units would be forced to endure extremely low experience levels indefinitely. It is also clear that experience will drop much faster with this policy option than with the historical default. This makes the system less stable in the sense that movement away from the equilibrium is more rapid when the system is perturbed. This means that circumstances can quickly deteriorate when the required parameter values are not precisely maintained. Indeed, our preliminary analysis indicates that this policy would take F-16 experience levels below 40 percent within 18 months.

Small changes in training capacity or aging rates created by the normal variance associated with these parameters could also cause major problems. The concept of maintaining an average UTE rate, for example, differs from flying exactly the same UTE rate consistently at every location. Moreover, manning would have to be kept within one pilot per squadron of authorized strength to ensure that these equilibrium-related training indicators can be maintained.

There are, however, situations in which we might prefer this option to the historical default. These would be limited to temporary circumstances that pertain only until more permanent policies can be implemented and only in circumstances where aircrew managers can be confident that small perturbations in policy execution will not bring grave consequences. Additional analytic options might be required before this policy option could be effectively used.

Next we examine excursions that remove the training capacity constraint in order to accommodate a 330-pilot production rate. The first deals with UTE rate and the second with force structure.

Increased Training Capacity: UTE Rate

The required UTE rate increase from the best case is about 1.6 sorties per airframe per month aggregated over all operational fighter units. This would take the aggregated fighter UTE rate from its programmed value of 18.5 to a value of 20.2, an additional 8.9 percent above the UTE rates that the CAF is currently striving to achieve. If we compare this required UTE rate to the value implied by the five-year average HCM values, the aggregate increase needed is about 2.5 sorties per airframe per month, or 14.3 percent. The key issue here is not to ascertain how accurate these estimates may be (because a number of assumptions are needed to make them) but rather to quantify the absorption shortfall in more meaningful terms. The 28-pilot absorption increase requires an aircraft UTE increase of sizable magnitude. We should observe that these percentage increases are no greater than the corresponding experience rate increases of 8.9 percent and 15.8 percent that they generate.

Increased Training Capacity: Force Structure

Next we will examine the force structure increase, measured in terms of PAA, that would be required to provide the necessary flying hours to increase the maximum absorption capacity to 330 pilots per year. The added sorties would require 103 additional aircraft authorizations flying at the best-case objective UTE rates to raise the absorption capacity to 330 pilots per year while maintaining an experience level of 50 percent at 100 percent manning. This means that 4.28 additional 24-PAA squadrons, or 1.43 additional active fighter-wing

equivalents (FWEs), are required to increase the absorption capacity to accommodate 330 new pilots each year. This represents an active fighter force structure increase of more than 11 percent—which is clearly a sizable increase, and one that provides a clearer view of the magnitude of the task the Air Force faces.

We should also observe that this force structure is adequate only to accommodate the current production rate objective of 330 fighter pilots per year. The force structure increase that corresponds to the *required* production rate of 382 fighter pilots, as was addressed in Chapter Three, is massive. It would require a PAA increase of 285 aircraft, or 31 percent, to boost the fighter absorption capacity to 382 pilots and maintain the other parameter value objectives. This is an increase of about four FWEs.

This is the only excursion that can accommodate the actual fighter production requirement of 382 pilots because other options do not generate reasonable value ranges for the remaining parameters. We will return to this issue only to develop its implications and will avoid further numerical excursions to accommodate this larger production number.

The size of the UTE rate and force structure increases that are necessary to meet current Air Force fighter pilot production objectives help us better appreciate the magnitude of the effort that will be required to achieve these objectives. These excursions share another advantage in that neither lengthens the TTE values required for the BCS. Indeed, the UTE rate option actually reduces TTE values. Thus, both of these options meet the production objectives without allowing TTEs to exceed the current ACC minimum TOS objective, which is two years and eight months. All of the numerical excursions are summarized in Table 5.2.

The numbers indicate that the fighter community may continue to operate in an extremely challenging training environment for an extended period of time. If production rates remain at 330 pilots per year and force structure increases are not feasible, an environment similar to that at Pope Air Force Base for every active fighter unit becomes a likely reality even if the best-case parameter assumptions all

Table 5.2

Summary of Numerical Cases

Variable	Best-Case Scenario	Historical Default	Fixed Manning Excursion	UTE Excursion	Force Structure Excursion
Pilots absorbed	302	330	330	330	330
Manning level (%)	100	>125	100	100	100
Experience level objective (%)	50	50	Not Specified	50	50
Actual experience level (%)	50	~40, 36 for F-15 and F-16	~40, 36 for F-15 and F-16	50	50
Inexperienced SCM aggregate, F-15/F-16	11 10.5/11.5	7.5 6/7	9.5 9/10	12 12/13	11 10.5/11.5
TTE (years)	<2.5	>3.5	< 3.0	<2.5	<2.5
PMAI hours aggregate, F-15/F-16	570 525/575	430 350/400	525 475/520	620 585/635	570 525/575
Parameter amount of change	NA	Manning level: >25 percent higher	Experience level: same value as default	UTE: 8.9 percent, 1.65 sorties/PAA	PAA: 11.1 percent, or 1.43 FWE
Viable steady state	Yes	No	No; preferred?	Yes	Yes

remain valid. The option for units to fly out of the troublesome environment with further increases in training capacity is constrained by the substantial UTE increases that may be required both to offset the effective force structure reductions that will accompany aircraft modernization and conversion programs and to maintain the best-case assumptions.

Chapter Six

IMPLICATIONS AND ALTERNATIVES

The numerical excursions discussed in Chapter Five indicate that the Air Force faces a serious aircrew management challenge. Under some highly optimistic assumptions regarding available force structure and training capacity, only 302 new fighter pilots can be absorbed into the operational units each year. First, if production continues at 330 new pilots per year, the flow of new pilots entering these units will lead to imbalances and could create a training environment similar to that observed at Pope Air Force Base and described in Chapter Two. Second, as described in Chapter Three, recent retention measures indicate that 382 new fighter pilots must be absorbed each year in order to meet the future Air Force requirements for experienced pilots. That is to say, a production rate of 330 fighter pilots is too large for the existing force structure to absorb but is at the same time too small to fill future billet requirements.

This conflict in objectives focuses our discussion on implications and available alternative policy actions. Bringing this imbalance under control will require that the Air Force either reduce the flow of incoming pilots or increase the capacity for operational units to absorb such pilots. We will examine both options in turn.

REDUCING THE FLOW OF INCOMING NEW PILOTS

The most direct means of reducing the absorption burden is, of course, to reduce production rates. Since fighter billets still need to be filled, however, the only way to cut production compatibly is to ensure that such cuts are accompanied by improved retention or requirement reductions (or both). We will examine both alternatives.

Retention

Natural retention rates have been obscured by activities that followed the terrorist attacks on September 11, 2001. A "stop-loss" order was implemented for active pilots, so retention will temporarily remain at 100 percent. These events have also affected airline operations. Hiring freezes and furloughs undoubtedly dampen the external appeal that the major airlines have held for military pilots over the past several years. Over the long term, however, continued airline growth and mandatory age-60 pilot retirements will likely ensure that airline hiring will eventually resume.

Our site visits found that retention problems may also be related to the low proficiency levels many pilots must now accept during an initial operational tour. There is a widespread perception that pilots who are not fortunate enough to receive consecutive operational assignments early in their careers may not gain sufficient knowledge to remain competitive for assignment and promotion opportunities later on. If this perception is valid, absorption problems themselves could eventually cause lower retention rates, further increasing concerns regarding inadequate pilot inventories. Also, as we noted in Chapter Three, retention (as measured by the BTR) must increase from 30 percent to 53 percent in order to make the 330-pilot production rate adequate to eventually meet current requirement levels.

Thus, any reductions in pilot production that are based solely on anticipated improvements in pilot retention would probably prove premature. Even though retention could improve somewhat in the future, we advise waiting to see. This is not meant to imply that the Air Force can end its current pilot retention initiatives and efforts. Although improved retention should certainly remain a critical goal as well as an important component in reducing absorption problems, it is unlikely to become the only pure strategy that is pursued toward that end. Moreover, further declines in retention could prove devastating.

Reducing Pilot Requirements

Cutting pilot requirements could allow a lower production rate to be compatible. Indeed, the Air Force's pilot prioritization process determines which authorized billets will be filled and recognizes that

some requirements outweigh others. An argument might be made simply to eliminate the requirements that have the lowest priorities. The lowest-priority billets are always among the nonabsorbable billets and are typically in the nonflying staff.

Figure 4.2 shows that such billets have already decreased during the drawdown at greater rates than have total requirements, so the relative absorption capacity has improved. Figure 4.3, however, shows the reverse for fighter pilots, whose shortages are already most critical: "Advanced" billets have increased relative to the total number of fighter billets. The reasons were discussed in Chapter Four. The relative absorption capacity for fighters decreased during the drawdown period.

The number of fighter requirements continues to drop, however, and the outyear requirement of 4381 is almost 10 percent fewer than the 4830 required in FY 1999. Part of this decrease is due to force structure reductions, which tend to exacerbate absorption problems, but a portion is due to Air Force initiatives to use alternative manning sources to cope with the pilot shortfall. We will describe these alternative manning sources and explain why it is unlikely that they will improve the results we obtained in our numerical excursions.[1]

Alternative Manning Options

One alternative manning source incorporates associate programs that replace active-duty pilots with experienced reserve or guard pilots. The new programs began in UFT units, where 225 active billets were converted to reserve billets. Shifts are under way in fighter FTU units as well, where 66 active billets will be converted. An additional 73 depot and test support active billets have also been converted. Moreover, a successful test in one operational F-16 unit has prompted the creation of a program to expand that concept. Our

[1]The percentage reduction in total pilot requirements since FY 1990 is about 40 percent, while nonflying staff billets have decreased nearly 60 percent in the same period. (The Air Staff provided all the data quoted in this section.) Many of these billets can be filled by navigators with appropriate operational experience; this has been an effective alternative in recent years because of navigator overages with F-4 and F-111 experience. Unfortunately, this option is temporary because all of the "excess" navigators are quite senior in years of service, and they will soon leave the aircrew management inventory as a result of promotion or retirement.

numerical excursions have incorporated all of the billet reductions currently programmed in outyear requirements. These programs may not be broad enough to generate significant further reductions in required billets, but they will help reduce the overall problems that the Air Force confronts.[2]

A second alternative manning source uses civilians to fill active billets that require aircrew expertise. Both contractor and government service options are being used to hire Air Force retirees with previous staff experience in the specific areas required. This option applies only to nonflying staff billets while the associate alternatives fill cockpit requirements, so the two programs are complementary. Unfortunately, the use of retirees shares the limitations in scope exhibited by the associate programs, and it is not clear that this procedure is sustainable over time if these individuals displace active-duty officers who would otherwise be gaining the necessary staff experience. Although both programs provide advantages in coping with the pilot shortfall, their primary intent is to deal with shortfalls that already exist. It seems unlikely that they could be expanded to reduce existing requirements to an extent that would resolve the future absorption problems addressed in our numerical excursions.

Total Force Absorption

High experience levels in guard and reserve units have led the Air Force to examine total force options to ease absorption constraints. The first option reduces the number of pilots who must be absorbed in active fighter units and does not require the production rates to drop. This controversial policy uses guard and reserve units to provide the initial operational tour for a limited number of FTU B-Course graduates so that not all must be absorbed into active units. Indeed, the 1999 Four-Star Rated Summit recommended that 30 pilots of the 330-pilot production goal be absorbed into guard and reserve units. This approach, called the *total force absorption policy* (TFAP), has the clear advantage of leaving the production rate at 330 pilots while the 300 pilots who enter active units remain within the absorption capacity given by the BCS with the 50 percent experience

[2]More information on the associate programs, including discussions of implementation issues, is contained in Taylor et al., 2000, pp. 33–38.

level. This would bring the imbalance under control, at least for the 330-pilot production rate, and experience levels could actually grow slowly if other parameters held to their best-case values. It is worth noting that, in terms of absorption capacity, the original TFAP program is equivalent to increasing the active force structure by roughly 1.5 FWEs.[3] It could also provide some of the flexibility needed to deal with variations in the BCS assumption values.

The TFAP policy also introduces difficulties, however, and agreement has never been reached among the service components on exactly how it could be implemented. Instead, the approach was replaced by a limited-experience (LIMEX) policy that puts active pilots into guard and reserve units (flying similar aircraft) after an initial tour in an operational active unit. This would be either a one-year remote tour or a two-year tour in a CONUS unit. The basic LIMEX policy agreement reduced the number of participating pilots from 30 to 26 per year, but further constraints make it unlikely that this quota can be filled.

It is instructive to calculate bounds for the potential effects of the LIMEX policy even if the 26-pilot quota were achieved. Although the policy requires that the entire active production quota initially go to active units, the reduction in man-years that LIMEX pilots would spend as inexperienced pilots in active units can be calculated. This reduction can be interpreted as an effective increase in the absorption capacity of those units. This enables us to make direct comparisons in the effectiveness of the program.

If 26 participating pilots were assigned to guard or reserve units each year after completing two years in an active unit, the overall absorption capacity for fighter units would increase from 302 to about 307 pilots, depending on the final implementation and distribution decisions. If all of the participating A-10 and F-16 pilots were placed with the guard or reserve following a one-year remote tour, the overall absorption capacity would increase to roughly 315 pilots per year. An equivalent interpretation is that the program has the potential to reduce the effective flow of new pilots into active units by some five to thirteen pilots per year, depending on final implemen-

[3]This assumes the current training capacity assumptions with experience and manning levels at 50 percent and 100 percent, respectively, in absorbing active units.

tation decisions. Unless current rules are revised, the potential impact of the program could be limited to an effective-flow reduction of only four to six pilots per year. Thus, the LIMEX policy cannot fully resolve the absorption difficulties caused by the 330-pilot production rate, and it has only marginal potential for addressing the problems associated with higher production levels.[4]

More absorption-efficient total force alternatives are available, but they require the creation of new kinds of units that include pilots from both active and reserve components. The Air Force is examining several Future Total Force (FTF) initiatives that could test the ability of unit constructs to ease absorption constraints. Included in this investigation are *active associate* programs that incorporate active pilots in reserve component units, as well as *blended units* that contain active, guard, reserve, or civilian members, depending on specific unit needs. The absorption efficiency of these units can be illustrated with a simple example. A typical active 18-PAA squadron supports nine experienced API-6 pilots and requires at least 12 experienced API-1 pilots to operate effectively at an experience level above 50 percent. This leaves only 11 billets (for MDSs with a 1.25 CR) that can be filled with inexperienced pilots if the unit is to remain at a manning level of 100 percent. If the TTE in this unit averages 2.5 years, we can solve Eq. (4.8) for this squadron and conclude that it could take in only 4.4 (= 11/2.5) newly produced B-Course graduates (on average) per year to maintain experience and manning objectives. This means that this squadron configuration requires more than 4.75 (=[9 + 12]/4.4) *experienced* active pilots to absorb one new inexperienced pilot each year. Twenty-four-PAA squadrons, which have the same number of supported API-6s, are more efficient

[4]TFAP implementation was hampered primarily by cultural issues and funding difficulties. See Taylor et al., 2000, pp. 29–33, for more on the background underlying some of these problems. The Air Force believes that LIMEX should be a voluntary program, and there are no active F-15 remote units or guard or reserve F-15E units. Thus, LIMEX participation will remain constrained. According to information presented at the 2001 Four-Star Rated Summit, the program had placed 16 LIMEX pilots in guard and reserve units in FY 2001, with 22 and 24 planned for FY 2002 and FY 2003, respectively, and an ultimate limit of two active pilots per nonactive squadron. There are fewer than 35 guard and reserve units with compatible aircraft and mission tasking, so no more than 70 active LIMEX pilots can participate at one time. Because pilots will be assigned to these units for controlled three-year tours, this means the 26-pilot-per-year rate cannot be sustained over time.

by this measure, as are A/OA-10 units that have higher CRs.[5] The Air Force has considered and rejected higher CRs for other fighters because of aircraft UTE constraints, but we know of no historical information that tests fighter aircraft authorizations exceeding 24 PAA per squadron.

Operational guard and reserve units have collective experience levels near 90 percent, while experienced fighter pilots are in very short supply in the active force, so the advantages of shifting some of the experience needs into the reserve components in order to absorb more new active pilots are immediately apparent. These advantages go beyond the simple implications of using more airframes to absorb more pilots. Preliminary investigations indicate that shifting the API-6 needs will yield more absorption efficiency than shifting API-1 needs alone, but additional analysis will be required to determine what kinds of unit combinations can provide the best blends of absorption efficiency and mission effectiveness for the CAF. These unit constructs currently do not exist in the fighter community, and only by incorporating them into a long-term approach could they ease absorption difficulties. Finding a long-term alternative, however, could allow decisionmakers to focus on transitional methods that achieve long-term resolution more efficiently and effectively.[6]

INCREASING ABSORPTION CAPACITY

Since absorption capacity is based on training capacity adjusted for the sortie distribution effects that determine aging rates, we will first examine training capacity. Many methods for increasing capacity are already under examination by the Air Force.

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[5]Twenty-four-PAA squadrons require 4.0 experienced pilots on average for each new inexperienced pilot absorbed. A/OA-10 squadrons, which have higher CRs than the 1.25 used in these calculations, are more absorption efficient than are other fighter MDSs, requiring 4.0 and roughly 3.5 experienced pilots, respectively, for 18- and 24-PAA units per newly produced pilot. It is also worth observing that the A/OA-10 CR increases implemented during the drawdown have reduced the programmed SCM and HCM values for pilots in those units.

[6]These FTF initiatives are being examined at the direction of the Office of Reserve Affairs under the Secretary of Defense. The information in this paragraph was provided by HQ USAF/XPX in *RAND Reserve Components Comprehensive Review*, a presentation made in January 2002. The potential options require extensive additional study.

Increased UTE Rates

The Air Force has several actions under way to increase (or at least maintain) the sortie pool available for aging new pilots. These include commitments to standardize aircraft UTE rates and to fully fund and fly the flying-hour program. Staff agencies are also examining options to increase fighter UTE rates even further to offset the loss of available aircraft that will result from modernization and conversion programs. It is essential that these initiatives succeed, however, if units are to achieve the sortie-pool numbers that we calculated with the best-case-assumption values for our previous numer-ical excursions. It is unlikely that they can provide much of the additional 8.9 percent UTE rate increase needed to absorb even 330 new pilots per year. In total, this requires almost a 15 percent increase over recent historical UTE rates, so it is clear that UTE rates cannot be pushed high enough to absorb the 382 new pilots required to meet long-term needs. We should also note that aircraft UTE limits provide the primary constraints that prevent CR increases in existing units. In turn, this prevents units from increasing absorbable billets without increasing force structure.

Increased Force Structure

Another means of expanding the available sortie pool would be to increase the active component's fighter force structure. There are two aspects to this approach. The first is to redress the decline that will accompany scheduled modernization and conversion programs. This could potentially hedge against the decreased training capacity units will face if additional UTE rate increases cannot compensate for the expected inventory reductions below existing PAA levels. The terrorist attacks on September 11, 2001, may generate additional tasking and training needs that will make it more critical for units to stay at authorized levels throughout the modernization and conversion programs. The need is underlined in view of our numerical finding that 11 percent more PAA—or almost 1.5 additional FWEs—are needed just to raise fighter absorption capacity to 330 pilots per year.

A second prospect is to actually add aircraft authorizations. If these authorizations created additional active units, they would improve

overall experience rates without actually increasing aging rates for individual pilots because more pilots would be able to age at the existing rates. But adding authorizations to existing units (by increasing some squadrons from 18 to 24 PAA, for example) would improve aging rates even further by distributing a higher proportion of the parent wings' available sorties to API-1, rather than API-6, pilots.[7]

Force structure increases in the active fighter force have been controversial for some time because of the budgetary increases they would require. Since the drawdown in the early 1990s, Air Force programmers have been extremely skeptical about initiatives that require increased expenditures, and absolute PAA increases have been deemed infeasible. Irrespective of the feasibility of future increases in PAA, however, past PAA reductions are a primary cause of the developing absorption problems. Figure 6.1 shows the history of combat-coded (CC-coded) fighter authorizations for operational units.

It is worth noting that the active fighter *PAA reduction* since FY 1988 exceeds the total authorization for FY 2001. In view of the limited effect of potential UTE increases, it becomes clear that options that do not address this reduction directly or indirectly will be hard-pressed to achieve the absorption capacity increase required to resolve the approaching crisis.

Increased Aging Rates: Sortie Redistribution

An option that could increase aging rates without a corresponding increase in training capacity would be to change the manner in which the available sortie pool is distributed to inexperienced pilots. The two primary factors that govern this distribution are manning levels and experience levels, and we noted in Chapter Five that pilots

[7]The Air Force already has a program to "robust" several 18-PAA squadrons to 24 PAA because of the increased scheduling flexibility provided, but modernization and conversion issues jeopardize its ability to sustain this initiative. Wings with 24-PAA squadrons can distribute a higher percentage of the sortie pool to API-1 pilots because the wings require essentially the same number of API-6s regardless of the aircraft authorization levels of its squadrons. Thus, all of the extra sorties attributable to the additional aircraft can be distributed to API-1 pilots. Twenty-four PAA squadrons also benefit because they can build maintenance and flying schedules more efficiently than can 18-PAA squadrons.

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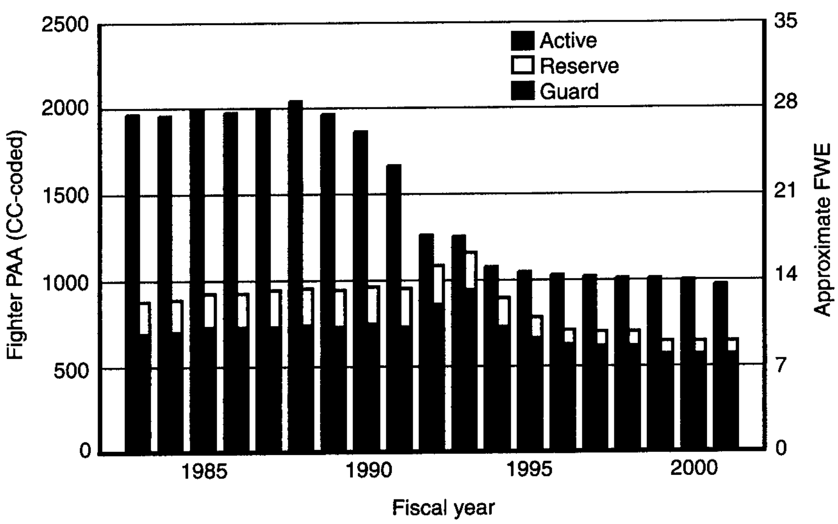

NOTE: All aircraft authorizations for operational units are CC-coded. An approximation of the corresponding changes in FWEs is given on the right-hand axis. These numbers are approximate because they include small numbers of aircraft (such as OA-10s or air defense force [ADF]–tasked units) that are not usually included in FWE calculat-ions. Small numbers of nonabsorbable aircraft (such as F-117s) are also included. Data are from the Air Staff (AF/XPPE).

Figure 6.1—Active Fighter PAA Reductions Are Central to Current Absorption Problems

age faster in low-experience units in which manning levels are constrained rather than allowed to grow naturally. More information is needed, however, to determine how aircrew managers can deal with system instabilities and effectively correct for the large responses that might accompany small changes in input parameters. Experience levels must continue to be monitored as well because they can be a primary indicator of potential problem areas.

The third factor that governs how many of the available sorties can be flown by new pilots is the distribution of sorties between API-1 and API-6 pilots. In the force structure discussion, we considered the Air Force's ongoing initiative to increase squadron aircraft authorizations from 18 to 24 PAA. This option can improve the proportion

of sorties available to API-1 pilots even when it is accomplished in some units by closing other units, and it represents no net increase in force structure.

This option can help absorption because a fighter wing requires essentially the same number of API-6 billets to manage three 24-PAA squadrons, for example, as it needs to manage three 18-PAA squadrons. Thus, a wing with 24-PAA squadrons can devote virtually all of the additional airframes' training capacity to API-1 pilots. From an absorption perspective, this is equivalent to adding another 18-PAA squadron devoted entirely to supporting API-1 flying. (This discussion relates directly to the absorption efficiencies for larger units that we addressed in the total force discussion above.)

It can also help to include more similarly equipped squadrons in the same wing because wings whose squadrons fly distinct aircraft often require relatively more staff billets to manage the operations. Organizations with fewer squadrons, such as the group at Pope Air Force Base, are also less efficient in their ability to distribute sorties to API-1 pilots.

The importance of these factors leads us to consider whether our analysis needs to examine whether other options are available to redistribute sorties from API-6 pilots to API-1 pilots. We are not optimistic in this regard. Indeed, the sortie distribution between API-1 and API-6 pilots used in our numerical exercises may be among the more tenuous of our best-case assumptions. This is because we used the ACC programming method for this distribution, which assumes that API-6 sortie requirements do not vary with changing unit conditions or tasking.

Changing experience and manning levels, however, can definitely influence API-6 sortie needs. As experience levels drop in operational units, for example, squadrons typically require more API-6 support to ensure that adequate numbers of IPs and flight leads are available to provide essential in-flight supervision, since fewer qualified API-1 pilots are available in the squadrons. When units are overmanned, moreover, commanders may well overman the API-6 billets in higher proportions than those of API-1s because BMC API-6 pilots require fewer sorties to remain certified than do CMR API-1 pilots. This would also require that more sorties be flown by API-6

pilots even though the API-1 manning levels might appear less problematic.

API-6 sortie needs can increase if our assumption is incorrect that the home-station training distribution developed at the ACC will always apply. In fact, when units conduct flying operations at more than one location, additional API-6 support is normally required to ensure appropriate supervision. API-6 pilots are often used as well to increase CRs for deployed elements (unit type codes, or UTCs).

Increased Aging Rates: Longer Sorties

Aging rates could also be increased without augmenting the available sortie pool if the units flew longer sorties on average, providing more flying hours per sortie. Longer sorties, however, do not necessarily provide additional training or experience. Instead, the dual Air Force objective to increase aircraft UTE rates *and* to fund and fly the flying-hour program is the appropriate approach. If flying hours are emphasized over sortie counts, increased average sortie lengths will become a focal point. In operational fighter units, however, many of the techniques that serve to increase sortie lengths—such as restraining aircraft performance to improve endurance or carrying additional external fuel tanks—tend to degrade the training each sortie actually provides. Because this is not a desirable outcome, care must be exercised to ensure that it does not become an unintended consequence of policy decisions.

Additional options could increase the number of pilots who become experienced without increasing aging rates at all.

Increased Experience Rate: Longer Operational Tours

If pilots could remain in their initial operational assignment cycle for longer periods, more of them would become experienced even if aging rates remained relatively low. The main problem is that if inexperienced pilots remained on station for longer periods, experience levels would decline, decreasing aging rates and increasing TTEs. If, in addition, their presence created overmanning, the deterioration in aging rates would be exacerbated. A steady-state analytic approach can calculate the TOS change needed to match the TTE at the initial

aging rate, but it cannot address the additional increases in TTE caused by these dynamic factors. Although this option will never resolve absorption issues on its own, it could contribute to that goal as part of a comprehensive package.

Increased Experience Rate: Lower Standards

The final method of increasing experience rates is simply to adjust the definition of an "experienced" pilot to conform to the existing reality. This may evolve as an eventual default approach in the absence of specific policy decisions to prevent it, and it would not be without precedent. If new fighter pilots can get only 300 to 400 hours on average in their primary mission aircraft during an initial CONUS operational tour, is it unreasonable to agree that they are now experienced? Conditions may well have changed since the original 500-hour requirement was implemented under RDTM, and the actual experience gained during the initial operational tour may be equivalent in the current training environment to the previous 500-hour criterion.

Unless ways can be found to increase the training available per flying hour, however (possibly through greater use of simulators), lower standards will yield less capable pilots. The Air Force can give up capability in two ways. First, pilots can be tasked to perform all of the missions they must currently master, but they will have learned to do them less effectively by the time they are considered experienced. (They will, of course, continue to learn once they have met the new experience criteria.) Second, pilots can be tasked to perform fewer missions but required to master each of them as well as they do currently. Some might argue that the latter approach has been taken in the F-16 Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) community, where several specialized low-level requirements and the Killer Scout mission have been removed from unit training tasking. Much of the associated savings in training requirements has been offset, however, by additional technical training, such as the use of night vision goggles, and by additional mission tasking, such as combat search and rescue and airborne forward air control. This illustrates the problems associated with such an approach.

Indeed, there is evidence that changes are already evolving in the definition of experience, at least in a de facto manner. A primary application of the original 500-hour-experience criterion under RDTM, for example, was to determine eligibility for a shorter requalification TX-Course for pilots to reestablish mission currency before returning to a fighter cockpit following a nonflying (or non-PMAI) assignment. Three fighter FTU programs have already reduced standards for training syllabus eligibility to as low as 300 hours or one operational tour to accommodate lower flying-hour totals. Further, the eligibility criterion for A-10 pilots to enter formal I-Course training from an operational unit to become an FTU instructor was recently reduced from 500 hours of PMAI to qualification as a four-ship flight lead. Many of the initial candidates to enter under this new criterion, however, were upgraded to four-ship flight-lead status only in the final month of their operational tour. This could be interpreted to mean that commanding officers were willing to upgrade these pilots to ensure that they would be eligible for reassignment but were unable or unwilling to use the pilots as four-ship flight leads in their own units.[8]

It may become necessary for the Air Force to lower experience standards to ensure that new pilots can meet those standards. This action should be taken only with a full understanding of its ramifications. Experienced pilots must provide appropriate supervision, instruction, and complex staffing functions for the Air Force and joint organizations. Any changes in the current definition of "experienced" must be evaluated within the context of these needs. The decision deserves careful study and should not be allowed to become a default position without a prior assessment of its possible implications, especially potential unintended consequences. Decisionmakers may find ways to improve aging rates by providing missing training through alternative means, such as simulation, or they may simply be forced to accept lower levels of proficiency and knowledge from pilots who meet new "experience" criteria.

[8]The A-10 eligibility standards were lowered last year following earlier reductions in the F-15 and F-16. Pilots who are not eligible for a TX-Course requalification have historically been extremely unlikely to be allowed to return to operational flying in fighters following a tour of another type. I-Course eligibility information was provided during our visit to Davis-Monthan Air Force Base.

Such possibilities need to be carefully weighed, however, against the reality of placing the operational fighter world in a completely unprecedented regime of experience and manning. Without corrective action, fighter units' experience will drop to levels previously seen only in combat conditions, and combat conditions traditionally guaranteed flying opportunities that ensured aging rates for surviving pilots far exceeding those projected if manning levels were allowed to continue to increase. This reality has the potential to place the entire fighter fleet in a permanent environment similar to that temporarily observed in the A-10 community during FY 2000, and it must be approached cautiously.

CONCLUSIONS AND RECOMMENDATIONS

Our primary conclusion is that the Air Force must develop a set of policy options that enable it to build an inventory that will eventually meet its requirements for fighter pilots while maintaining acceptable training conditions in its operational units. We do not believe that these units should function for long with conditions that are worse than 100 percent manning and 50 percent experience. Maintaining these levels is essential for an acceptable operational training environment, and we do not believe they can be compromised. Indeed, we regard 50 percent experience as a minimum acceptable level, and we would prefer to see conditions established that permit experience levels to gradually grow toward the 60 percent value that enables inexperienced pilots to fly roughly the same number of sorties on average as experienced ones.

This means that the Air Force must find initiatives whose parameter values grow inventory levels to match requirements and simultaneously maintain the flow of new pilots within the absorption capacity of the operational units. We have seen that this may be extremely difficult in that there are serious constraints on available options.

Although the UTE and flying hour programs must be fully funded and flown, we do not expect that UTE increases alone can resolve the absorption crisis. Indeed, we have seen that it is extremely unlikely that UTE rates will exceed the increased values required for the units to deal with the reduced aircraft inventories resulting from scheduled aircraft modernization and conversion programs. Additionally, although retention initiatives are under way, we believe it would be

imprudent (even in the current airline hiring environment) for decisionmakers to assume that retention alone can resolve the impending crisis. Similarly, although several of the initiatives we addressed may contribute at the margins, they do not represent permanent solutions. These include alternative manning options, improved pipeline efficiencies, and longer tours.

We have also observed that several initiatives require increased analysis and may contribute very little toward resolving the impending crisis. These include redistributing sorties (in the absence of requisite PAA adjustments), lowering standards (with no increases in training efficiency), reducing requirements (with no workload redistribution plan), and lengthening sorties (achieved through degraded training).

This leads us to conclude that the only initiatives that can permanently resolve Air Force fighter pilot absorption issues are those that address the PAA reductions depicted in Figure 6.1. PAA increases can be achieved directly through net force structure increases or indirectly through a restructuring of the available force structure to increase absorption capacity, but the fundamental PAA problem must be an essential component in any policy program that provides permanent resolution. Moreover, the component PAA breakdown shown in Figure 6.1 suggests significant potential for options that provide more creative use of the total force, especially if sizable direct PAA increases are not feasible for active units. Thus, three fundamental options can deal with PAA shortfalls:

1. *Direct* active PAA increases, achieved by adding new units or increasing PAA authorizations in existing units.
2. *Indirect* active PAA increases, achieved by reorganizing active units to improve absorption capacity. For example, the existing active PAA could be redistributed so that more wings contain at least three 24-PAA squadrons. This implies that some units would be closed in order to make others more robust.
3. *Effective* PAA increases, achieved by making more creative use of the force structure available in all three components. Active associate or blended units, for example, could enable the existing PAA to absorb new pilots much more efficiently than the options we evaluated using active assets only.

Major obstacles face each of these initiatives. Their direct costs generate major budgetary implications, but their indirect costs must also be evaluated. Serious political issues, for example, are associated with the second and third options, and the third option also requires organizational innovations that have not yet been tested. It must also overcome cultural differences that have thus far prevented multicomponent cooperation to improve absorption. Such obstacles make it unlikely that any of these options alone can resolve the absorption crisis. The Air Force must examine policies that incorporate portions of all three options in order to find a long-term resolution of the crisis.

We recommend that the advantages and costs of potential long-term policies be examined thoroughly and quickly to assess their potential for resolving the absorption crisis. This process should evaluate options for closing bases and mixing force components to determine their relative advantages and potential effectiveness, and it should also consider possible adjustments in retention or requirements that may be needed.

These results should be compared to the problems that will arise if no action is taken and operational units continue to proceed toward the new equilibrium conditions associated with the excessive inflow of new pilots. We believe that decisionmakers will not want to allow the training environment that existed at Pope Air Force Base to prevail in *every* operational active fighter unit.

We note emphatically that the current production quota of 330 pilots has not been consistently achieved since goals were initially increased in FY 1996, so current conditions do not reflect the steady state dictated by those policy objectives. Conditions in the operational units have recently shown dramatic improvement as a result of production cuts and pilot redistribution efforts. At the same time, aircrew managers have been able to mitigate current nonflying staff shortfalls by using excess numbers of rated navigators who will soon exit the inventory following promotion or retirement. Temporary civilian fills have also offset some of these shortfalls. Thus, current circumstances are actually much better than those that will eventually result if current policy choices remain unchanged.

Any long-term solution to allow fighter pilots to move to follow-on assignments with significantly less experience and training than has historically been the norm should be made deliberately, not by default, and should be based on a thorough understanding of the implications.

Moreover, starting with the F-22 conversion, important policy decisions that affect future force structure should carefully examine the implications for absorption. Current imbalances have created a fragile system that requires continuous attention.

An acceptable long-term solution should be identified and agreed on and an implementation policy developed to take operational units to acceptable equilibrium conditions in a logical and sensible manner. This will require a better understanding of the dynamic processes involved, especially those associated with ongoing conversion and modernization initiatives. Aircrew managers recognize how absorption crises can corrode readiness, combat capability, and safety. The problem calls for a comprehensive analytic framework that reflects the system's complexity—a complexity that is often difficult to grasp and communicate. A dynamic modeling framework, coupled with a comprehensive longitudinal database, could provide the near-real-time indicators that decisionmakers need. The dynamic effects on the entire system need to be examined in order to avoid unintended consequences and formulate informed decisions. Policies, parameter values, and definitions may need to change over time.

The Air Force is facing the most challenging aircrew management problem in its history. No apparent single alternative can resolve all of the absorption problems in fighters. A combination of options will be required, and many initiatives may be essential simply to ensure that absorption problems become no worse than we estimated in our numerical excursions.

If policy alternatives that enable the system to operate in viable steady-state conditions cannot be implemented, the Air Force will enter uncharted aircrew management territory that will take the entire active fighter community for an extended period into the corrosive conditions documented in Chapter Two. Leaders will have to

considerably revise their expectations regarding the knowledge and capabilities of experienced pilots whether serving in line, staff, or supervisory billets. This should not be allowed to happen by default.

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The U.S. Air Force currently faces unprecedented problems in its efforts to provide adequate training for new and inexperienced pilots in its operational fighter units. On the one hand, there are too few fighter pilots in the active component to meet current and anticipated demands. On the other hand, the number of new fighter pilots entering operational units currently exceeds these units' absorption capacity, yielding a degraded training environment that ultimately threatens to compromise military readiness. This report assesses the Air Force's training dilemma with a view toward finding ways to remedy it in both the short and long term. Toward this goal, it defines the key parameters that influence a unit's absorption capacity, presents a best-case scenario on which to base numerical analyses, and offers several options decisionmakers can exercise. Although there is no simple resolution to the Air Force's training problem, a thorough understanding of the dynamic processes involved in aircrew management, together with a comprehensive analytic framework, promises to greatly aid decisionmakers in their efforts to address this issue.

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